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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 5971–6672

VOLUME 54 **AUGUST 1951** NUMBER 644

A Versatile Coating Unit with

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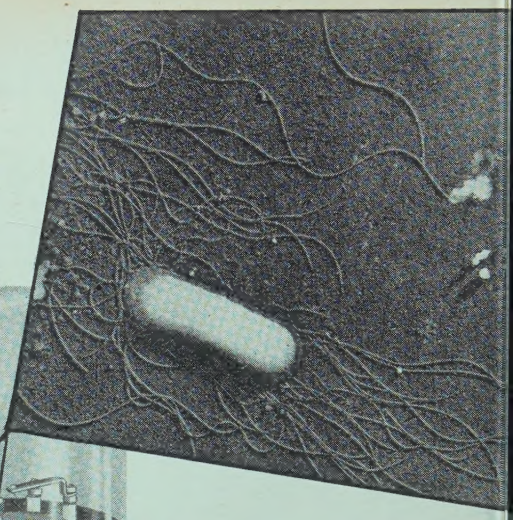
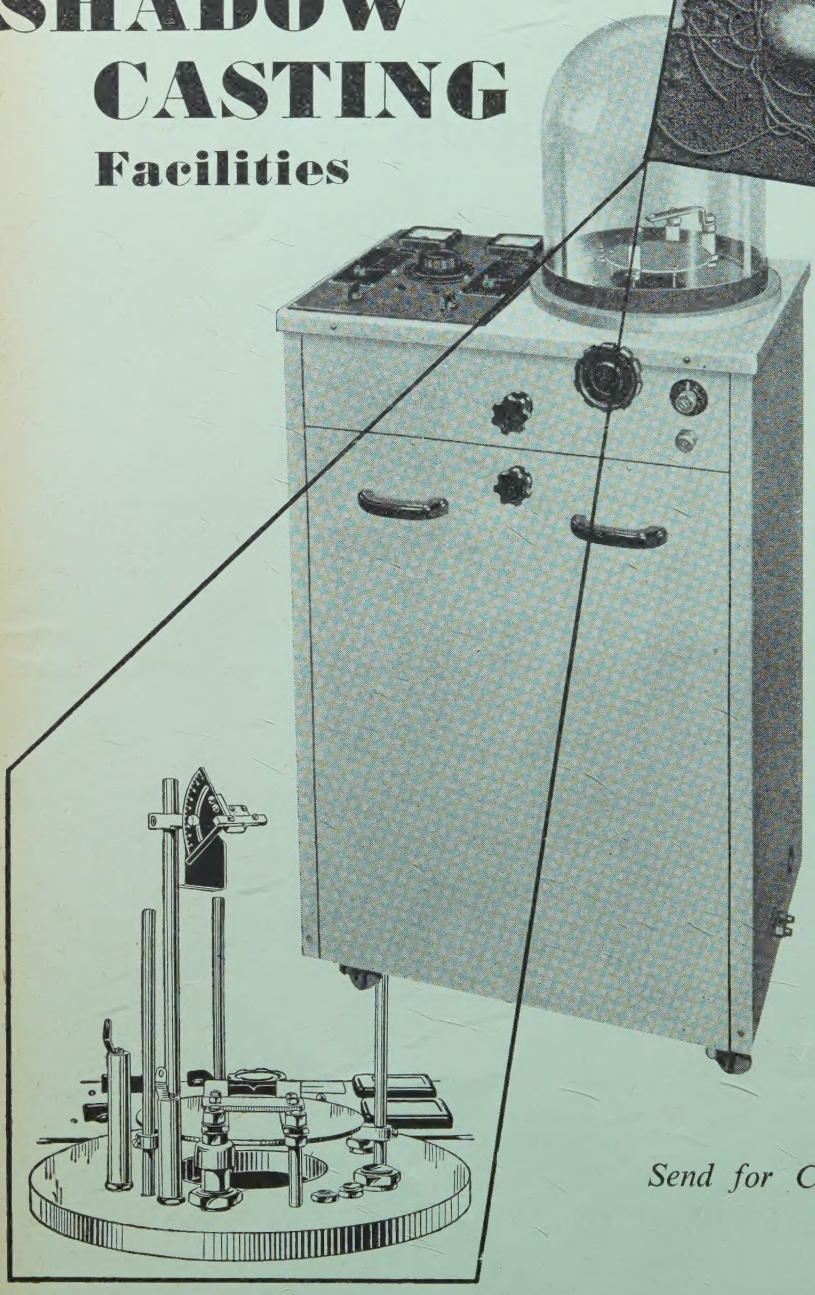


Bacillus Proteus shadowed wit chromium metal, showing wavy uniformly wide Flagella. (Repro duced by the courtesy of the Depart ment of Biomolecular Structure Leeds University.)



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Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

Ann. l'Acfas	*Annales de l'Acfas.* Association Canadienne-Française pour l'Avancement des Sciences, l'Université de Montréal, 2900 Boulevard du Mont Royal, Montreal 26.
**Jap. J. Astron. Geophys.*	*Japanese Journal of Astronomy and Geophysics* [Now *Japanese Journal of Astronomy* and *Japanese Journal of Geophysics.*]
Jap. J. Astron.	*Japanese Journal of Astronomy.* Science Council of Japan, Ueno Park, Tokyo.
**Medd. Met. Inst. Uppsala*	*Meddelanden från Meteorologiska Institut.* Uppsala.
Mem. Fac. Sci. Engng, Waseda	*Memoirs of the Faculty of Science and Engineering.* Waseda University, Tokyo.
Proc. Nat. Acad. Sci. India, Sect. A	*Proceedings of the National Academy of Sciences, India, Section A.* University Science Buildings, Allahabad.
Siemens Z.	*Siemens Zeitschrift.* Siemens-Schuckertwerke Aktiengesellschaft, Hauptwerbeabteilung, Sieboldstrasse 5, Erlangen.
Techn. Rep. Osaka Univ.	*Technology Reports of the Osaka University.* Faculty of Engineering, Osaka University, Higashinoda, Osaka.
Telegr. en Telef.	*Telegraaf en Telefoon.* Vereniging van Hoger Personeel der PTT, J. W. Frisolaan 36[b], Breda.
VDE-Fachberichte	*VDE-Fachberichte.* VDE-Verlag, Friedrich-Ebert-Strasse 111, Wuppertal-Elberfeld.
**Z. phys. Chem.*	*Zeitschrift für physikalische Chemie.* Akademische Verlagsgesellschaft. Geest & Portig K.-G., Leipzig.

Notes

British Abstracts. Change of address: Colquhoun House, Broadwick St., London, W.1.

Fortschritte der Radiotechnik. The 1950/51 volume, comprising five parts issued separately, also serves as Vol. 12 of *Handbuch der Funktechnik.* The publication of *Fortschritte der Radiotechnik* in separate parts will be discontinued henceforward, and it will appear as an annual volume only.

Observatory. Change of address: The Royal Observatory, Herstmonceux Castle, Hailsham, Sussex.

MATHEMATICS 51

512.831 : 526

5971. Systematization of numerical matrix calculations. P. L. BAETSLÉ. *Bull. Géod., No.* 19, 22–41 (*March*, 1951) *In French.*

Describes procedures for multiplication of matrices, decomposition into product of triangular matrices, calculation of determinants and principal minors, inversion of matrices and solution of linear equations [very similar to procedures given by L. Fox, *J. Roy. Statist. Soc., Ser. B*, **12**, 120–36 (1950)]. A. H. COOK

517.93 : 534.1

5972. Vector representations of differential equations, their solutions and the derivatives thereof. A. H. BOERDIJK. *Technische Hogeschool, Delft* (1951) 177 *pp.*

The equations considered are of the form $a_0\ddot{x} + a_1\dot{x} + a_2x = y(t)$. When the coefficients are constants and the forcing term is zero, the solution x and its derivatives are represented graphically as projections of a rotating vector. The method is extended to non-linear equations, when the coefficients vary slowly with t or are step functions, and is also used in a discussion of forced oscillations arising from a series of pulses. Subharmonic oscillations for periodic disturbing forces are also considered. R. A. NEWING

517.941.9

5973. The factorization method. L. INFELD AND T. E. HULL. *Rev. Mod. Phys.*, **23**, 21–68 (*Jan.*, 1951).

An operational procedure for use in eigenvalue problems. The underlying idea is to consider a pair of first-order differential-difference equations which are equivalent to a given second-order differential equation with boundary conditions. For a large class of such differential equations the method enables us to find immediately the eigenvalues and a manufacturing process for the normalized eigenfunctions. These results are obtained merely by consulting a table of the 6 possible factorization types. The manufacturing process is also used for the calculation of transition probabilities. The method is generalized so that it will handle perturbation problems. A.

517.942.9

5974. Initial conditions in linear varying-parameter systems. L. A. ZADEH. *J. Appl. Phys.*, **22**, 782–6 (*June*, 1951).

See Abstr. 4031 (1951). The problem considered in this paper is that of determining the response of an initially excited linear varying-parameter system to a given input. Mathematically, this problem reduces to solving a linear differential equation (with time-dependent coefficients) subject to prescribed initial conditions. It is shown that these conditions may be satisfied by superposing upon the given input a linear combination of delta-functions and treating the system as if it were initially at rest. Based on this fact and employing the concept of a system function, a general and yet simple expression for the response is developed. The result is similar in form to that obtained by the use of conventional Laplace transformation techniques in the case of a linear differential equation with constant coefficients. A.

518.3

5975. Nomograms for the solution of the Kepler equation [$M = E - e \sin E$]. H. STRASSL. *Astron. Nachr.*, **279**, 25–43 (*Sept.*, 1950) *In German.*

518.5

5976. Programmed digital calculators (electronic calculating machines)—a general survey. IV. H. RUTISHAUSER, A. SPEISER AND E. STIEFEL. *Z. angew. Math. Phys.*, **2** (*No.* 2) 63–92 (1951) *In German.*

Abstr. 4999 (1951) Pt III. Circuits using thermionic valves or electromagnetic relays are described which perform the elementary logical operations. The combinations of these to form adding circuits are shown. The operating principles of most of the storage devices now in use or proposed are described, and access time and storage capacity of some in use are given. S. MICHAELSON

518.5 : 621.318.572

5977. Special devices aid differential analyzer solution of complex problems. A. C. COOK, L. K. KIRCHMAYER AND C. N. WEYGANDT. *Trans Amer. Inst. Elect. Engrs*, **69** (*Pt II*) 1365–70 (1950).

For abstract see Abstr. 3260 (1951).

519.271

5978. Generalizations of Laplace's probability law. M. FRÉCHET. *Ann. Inst. Poincaré*, **12** (*No.* 1) 1–29 (1951) *In French.*

Two definitions are given for extending the classical definition of the Laplace (or so-called, normal) law of probability of a random number. Both apply to the case of a random element of any nature whatsoever, chosen in a distanced vectorial space. In the first one, X is called a Laplacian random number if $\mathfrak{L}X$ is a Laplacian random number for every linear functional $\mathfrak{L}X$. The second is a descriptive definition which does not presuppose what a Laplacian number is and is based on an extension of a theorem of Serge Bernstein. A

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.1 : 535.214

5979. The restricted problem of three bodies with allowance for radiation pressure. V. V. RADZIEVSKY. *Astron. J., USSR*, **27** (*No.* 4) 250 (1950) *In Russian.* English abstract in *Astron. News Letter* [*Harvard*] *No.* 55, 13 (*Feb.* 15, 1951).

The author considers the motion of a small partcile, influenced by radiation pressure, in the gravitational field of the sun and one planet. He finds that even for particles with a diameter of 1 cm the surfaces of zero velocity are distorted to such an extent that the point of libration L_2 arises earlier (that is for larger values of the Jacobi constant) than the point L_1. A.

522.56 : 621–526

5980. Servo guider for solar telescopes. F. E. FOWLER AND D. S. JOHNSON. *Electronics*, **24**, 118–22 (*May*, 1951).

Describes equipment developed at the Harvard Observatory to keep a coronograph pointing to the sun with an accuracy of 1 second of arc. Hour angle guiding is provided by a synchronous motor normally running at a fixed frequency. Error signals proportional to the sun's deviation in H.A. alter the frequency of the motor input. For declination guidance, where no constant input is required, driving power is provided by a two-phase induction motor. The optical guiding system consists of a small telescope producing an image of the sun on an occulting disk. Apertures in the E–W and N–S lines pass light to photo-cells from which the necessary error voltages are obtained. The associated electrical circuits are described and circuit diagrams given. A. C. CLARKE

522.617.3

5981. The electrical photometry of stars and nebulae. J. STEBBINS. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 5) 416–28 (1950).

A concise account of progress in photoelectric astrophotometry, with special reference to the method of 6-colour filter photometry of stars and nebulae developed by the author, and his collaborators, since 1942. D. R. BARBER

523.1

5982. Theory and practice in cosmology. O. HECKMANN. *Naturwissenschaften*, **38** (*No.* 4) 84–91 (1951) *In German.*

523.112

5983. Tests for the cosmological time scale. F. ZWICKY. *Publ. Astron. Soc. Pacific*, **63**, 17–25 (*Feb.*, 1951).

A decision with regard to the short time-scale should be possible without an exact knowledge of nebular distances and luminosities. In an expanding universe, the statistical distribution and physical character of nebular clusters would change with time, and thus with nebular distance. A comparison of near clusters with clusters at distances $\sim 5\times10^8$ light years would then provide a series of qualitative tests for the rival hypotheses of expanding and stationary universes. R. A. NEWING

523.161

5984. Experiments concerning interstellar polarization. W. HANLE AND H. SCHERER. Note in *Z. Naturforsch.*, **6a**, 165–6 (*March*, 1951) *In German.*

Astronomical evidence presented by Spitzer and Tukey, Davis and Greenstein, Hiltner, and others indicates that the observed polarization of star-light may be caused by small iron particles orientated in the magnetic field of interstellar space. The authors produce within a weak magnetic field an arc between two Fe electrodes and condense the γ-Fe_2O_3 vapour on a glass plate; the particles then form typical pearl-chains of pronounced polarization properties. The polarization becomes more and more constant towards the visible spectral range. This, too, agrees with the astronomical evidence: Hiltner found the degree of interstellar polarization to be nearly constant between 420–800 mμ. A. BEER

523.5 : 531.55

5985. The ballistic contribution to meteorics. R. N. THOMAS. *Harvard Coll. Obs., Tech. Rep. No.* 5, 25 *pp.* (1950).

A summary is given of the methods and results of the ballistic treatment of air resistance in the high-velocity range, with emphasis on deceleration and heat-transfer considerations, with a view to the development of the general problem in which a continuous transition exists between ballistics and meteorics when the parameters of velocity and air density are varied. M. W. OVENDEN

523.51

5986. The correlation of visual meteor data with the character of meteor radar echoes. P. M. MILLMAN AND D. W. R. MCKINLEY. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 494–5 (1950).

Visual, photographic and radar observations were made at Ottawa in 1947, especially during annual meteor showers, and the positions and orientations of the trail were calculated. Features of moving and long-enduring echoes and the delay in appearance are described. A correlation was found between the time the echo was visible and the visual brightness and velocity through the atmosphere. A theory indicates that a meteor (*M*)-region exists where ionization occurs at a mean height of 90 km and 15 km thick. Possible explanations of the types of echoes are given. R. S. READ

523.53

5987. The interpretation of radar echoes from meteor trails. J. FEINSTEIN. *J. Geophys. Res.*, **56**, 37–51 (*March*, 1951).

Electromagnetic-wave theory is applied to various cylindrically symmetric distributions of electron density to ascertain the dependence of reflected radio signals upon the system parameters. Two models have been mainly considered—a linear radial variation of electron density, and a constant density distribution. The general properties and dependences of the echoes are summarized for each major region of trail parameters, and the transitional characteristics are indicated. A qualitative comparison of these results with published observational data leads to a new picture of the trail decay period. A.

523.53 : 538.566.2

5988. On the reflection of radio waves from a meteor. T. YONEZAWA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 516–18 (1950).

Outline of a simplified approximate theory of the radio-wave reflection coefficient of a meteor trail. The results are exhibited graphically, permitting the ready calculation of the reflection coefficient under specified conditions. W. J. G. BEYNON

523.531 : 621.396.9

5989. A radio echo apparatus for the delineation of meteor radiants. A. ASPINALL, J. A. CLEGG AND G. S. HAWKINS. *Phil. Mag.*, **42**, 504–14 (*May*, 1951).

The apparatus comprises two Yagi aerial arrays on azimuthal bearings of 242° and 292° respectively, which are fed from the same transmitter and the returned signals are amplified and fed on to two display tubes. The range of the apparatus is about

1 000 km and the operating frequency 72 Mc/s. The method of radiant determination is that of Clegg [Abstr. 1280 (1949)] and it is shown that the accuracy of the method is ± 1° in right ascension and ± 1·5° in declination provided that the echo rate exceeds 30 an hour. The resolving power is shown to be such that under all circumstances two sources 20° apart will be resolved. J. M. HOUGH (R)

523.72

5990. A long-period change in radio-frequency radiation from the "quiet" sun at decimetre wavelengths. W. N. CHRISTIANSEN AND J. V. HINDMAN. *Nature, Lond.*, **167**, 635–7 (*April* 21, 1951).

Observations made in the period 1947–50 of solar r.f. radiation on 50, 25, 10 and 3 cm have been examined for evidence of a change in the effective temperature of the quiet sun. A comparison of measurements on 25 cm for the two periods 1947 and 1949–June 1950 indicated no marked change in the quiet sun temperature, but observations made in the latter part of 1950 on 10, 25 and 50 cm indicated distinct decreases of 20, 45 and 35% respectively. No perceptible changes were observed on 3 cm or on 150 cm. W. J. G. BEYNON

523.72 : 525.7

5991. On the pressure of solar radiation upon atoms of various gases. N. B. DIVARI. *Astron. J. Acad. Sci., USSR*, **27** (*No.* 6) 351 (1950) *In Russian.* English abstr. in *Astron. News Letter* [*Harvard*] *No.* 55, 5 (*Feb.* 15, 1951).

The ratio $(1 + \mu)$ of radiation pressure acceleration to solar gravitational acceleration is calculated for H, He, Na and Ca^+, a value of 0·1 for residual intensity of the appropriate solar line being assumed if an accurate value was not known. The largest value of $(1 + \mu)$ was 238 for Hα. Estimates of $(1 + \mu)$ in the earth's upper atmosphere show that normal radiation pressure will not produce a gaseous tail to the earth. Apparent values of $(1 + \mu)$ up to 2 125 are observed in comet's tails. M. W. OVENDEN

523.755

5992. The form of the monochromatic corona. M. WALDMEIER. *Z. Astrophys.*, **28** (*No.* 3) 262–76 (1951).

The height of the corona, as observed in the monochromatic light of the line 5303 Å, was measured at all heliographic latitudes on 176 days during the years 1939–50. The corona's height shows the same two zones of activity as were found for the intensity of this line along the sun's circumference. In the principal zone, which coincides with the zone of sunspots and faculae, the height of the corona follows the sunspot activity closely. The secondary zone moves in the direction of the poles from sunspot minimum to sunspot maximum. It is responsible for the strong development of the corona at the poles during a sunspot maximum. The monochromatic isophotes are more elongated in the direction of the equator than the isophotes of the continuous light of the corona. A.

523.755

5993. The radial distribution of the monochromatic corona emission. W. PETRI. *Naturwissenschaften*, **38** (*No.* 7) 155 (1951) *In German.*

Summary of the results obtained since 1946 by R. Müller with the Wendelstein coronograph of the University Observatory, Munich. A table gives the distances of the observed points from the sun's limb, in minutes of arc (0·1–2·4), and corresponding measurements of the intensity of the green Fe XIV line λ5303 Å. A. BEER

523.77

5994. The experiment in the electrophotometry of the solar spectrum. V. B. NIKONOV AND A. B. SEVERNYĬ. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 2) 217–20 (1951) *In Russian.*

Describes a simple recording solar electrospectrophotometer designed so as to work in conjunction with the diffraction spectroheliograph of the Crimean astrophysical observatory. The apparatus was used for (1) the investigation of the "centre-edge" effect in the contours of the strong *H* and *K* lines of ionized Ca; (2) the determination of the contours of *H* and *K* lines both in the centre of the sun and at a distance 1/40 from the edge near the pole; and (3) as a photoelectric spectroheliograph. F. LACHMAN

523.77

5995. Water vapor absorption lines in the solar spectrum between 8 μ and 13 μ. J. H. SHAW AND H. H. CLAASSEN. Letter in *Phys. Rev.*, **82**, 559 (*May* 15, 1951).

Lab. absorption spectra of 8 metres of steam, at 110°c and atmospheric pressure, prove that most of the irregularly spaced solar lines in this region are due to water vapour. D. L. EDWARDS

523.841.1 : 523.877

5996. The isotope ^{3}He in stars. Application to the theory of novae and white dwarfs. E. SCHATZMAN. *C.R. Acad. Sci., Paris*, **232**, 1740–1 (*May* 7, 1951) *In French.*

For stars possessing optimum conditions of temp. and density (values not specified), a weak concentration of He^3 will accumulate from the reactions,

$$\begin{cases} H^1 + H^1 \rightarrow D^2 + \beta \\ D^2 + H^1 \rightarrow He^3 \end{cases}$$

The probability of a further reaction,

$$He^3 + He^3 \rightarrow He^4 + p + p,$$

with the formation of He^4, will be high for both types of stars. For novae, it is shown that 10^{-2} gm He^3 per gm of stellar matter, density 1 000, can start a shock wave, vel. 700 km/sec^{-1}, at a temp. 100×10^6 °K. For white dwarfs, He^3 will be very short-lived, and the reaction will not affect the vibrational stability. D. R. BARBER

523.842.3

5997. On a possibility to resolve spectroscopically several close binary stars. A. VAN HOOF. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 17) 10 *pp.* (1950).

When the two components of a spectroscopic binary are recorded with slit, or slitless spectrographs, at max. elongation (ang. separation, α), their radial velocities will be of opposite sign, and the resultant line displacement will be $(\delta + \alpha)$, δ being the sum of the Döppler shifts. On reversing the prism, the displacement becomes $(\delta - \alpha)$; and the relative ang. displacement, 2α, will give a measurable displacement

on spectrograms taken in the two positions of the prism. From a knowledge of the instrumental constants, the quantity, α, may be deduced. Various instrumental effects, including line broadening, are discussed, and measures of 31 selected double stars with known orbital elements are tabulated. D. R. BARBER

523.854.3

5998. Stars with reverse movement in a galaxy. J. IKAUNIEKS. *Latv. P.S.R. Zin. Akad. Vēst. No.* 8, 111–17 (1950) *In Latvian.*

Determination of movement of BD + 23°123 and BD + 20°5077 has shown that these stars belong to the stars whose reverse movement in the galaxy was discovered by P. Parenago in 1946. A list of all stars with negative V_θ is given. Stars with reverse movement appear to be the result of the existence of spherical sub-systems of stars with low velocity of rotation of their centroid and high dispersion of velocities. Such stars do not differ from any other stars, and move in any other direction only if their velocities exceed the velocity of the centroid.

J. LUKASZEWICZ

523.854.3

5999. On the differential effect of the galactic rotation. P. KUSTAANHEIMO. *Ann. Acad. Sci. Fennicae, Ser. A* 1, *No.* 81, 21 *pp.* (1950).

Possible velocity fields are derived under the assumption that the K effect would be of the same general form for all observers in the galactic plane; the dispersion of individual velocities is neglected and certain symmetry conditions are imposed. The possibilities are restricted to Oort's model by the further assumption that density decreases outwards.

R. A. NEWING

523.854.3

6000. On the gravitational potential of the galaxy. P. P. PARENAGO. *Astron. J. Acad. Sci., USSR,* **27** (*No.* 6) 329 (1950) *In Russian.* English abstr. in *Astron. News Letter* [*Harvard*] *No.* 55, 2–4 (*Feb.* 15, 1951).

It is proposed to determine the gravitational potential $\phi(R,z)$ from the combined distribution of the densities of different sub-systems [Abstr. 39 (1951)]. The circular velocity is expressed as $k_1R/(1 + k_2R^2)$ and it is deduced that in the galactic plane $\phi(R,0) = (k_1^2/2k_2)/(1 + k_2R^2)$, where k_1,k_2 are determined from observed velocity distributions. The escape velocity is estimated as 469 km/sec at the galactic centre and 314 km/sec near the sun. Intermediate sub-systems can exist almost as far from the galactic centre as flat sub-systems, but members of spherical systems may exceed escape velocities even for $R =$ 7·2 k/c. Rough data are used to estimate the variation of ϕ with z. In the neighbourhood of the sun $\phi \sim \phi(R,0) - 0{\cdot}119 \times 10^{14} z^2$ cm^{2}sec^{-2}.

R. A. NEWING

523.87

6001. The discovery and exploitation of spectroscopic parallaxes. D. HOFFLEIT. *Pop. Astron.,* **58** (*Nov.–Dec.,* 1950); **59** (*Jan.,* 1951) 45 *pp.*

A useful historical survey of the classification of stellar spectra and the development of luminosity criteria is followed by a critical examination of the various criteria used, and an analysis of the resulting luminosities with special reference to Eggen's photoelectric work on stellar clusters. D. L. EDWARDS

523.877

6002. Investigation of the mass-luminosity-radius relation. II. A. G. MASSEVICH AND P. P. PARENAGO. *Astron. J., USSR,* **27** (*No.* 4) 202 (1950) *In Russian.* English abstr. in *Astron. News Letter* [*Harvard*] *No.* 55, 10–11 (*Feb.* 15, 1951).

Theoretical interpretation of the relations found in Part I [Abstr. 52 (1951)]. The principal conclusions are: there is no single M, L, R relation for all stars. Hence, there is no single model which can explain all stars; not only the location of the stars in the HR diagram, but also their kinematical and spatial characteristics permit us to divide them into distinct groups for each of which there is a single M, L, R relation; the 2 groups of the main sequence, the giants and the supergiants, show distinct relations $L = f_1(M)$, $R = f_2(M)$ with different exponentials for each group; the relation $\mu = \mu(M)$ shows (*a*) that a model with a constant absorption coefficient is not possible except for stars of classes O and B, because it results in a negative He content; (*b*) for the 1st group of the main sequence the theory of a model with convective core leads to an increase of μ toward the later types; (*c*) for the 2nd group the same theory also demands an increase in μ; (*d*) for giants and supergiants a constant μ is consistent with the law of absorption, but this would require a different energy source. It is premature to draw conclusions for the white dwarfs; for subdwarfs and subgiants there is only one relation $L = f(M,L)$, which suggests the existence of a parameter λ in $L = f_1(M,\lambda)$ and $R = f_2(M,\lambda)$.

523.877

6003. Curves of growth. O. STRUVE. *Scientia,* **86** (*No.* 3) 81–90 (1951).

Astrophysical research has benefited greatly from the theory of the curve of growth which was first applied to astronomy by M. Minnaert, H. N. Russell and others, and which since 1934 has been a valuable tool in the researches of A. Unsöld, D. H. Menzel, K. O. Wright, C. T. Elvey and the author. It represents the relation between the number of absorbing atoms per square centimetre column of a stellar atmosphere, and the observed amount of absorption in a spectral line. Among the most valuable results secured with the help of a curve of growth was the discovery, in 1934, of violent turbulent motions in the atmospheres of supergiant and giant stars. Recent work on several exceptionally luminous stars has shown that the turbulent motions are not distributed in a random manner throughout the atmospheres of the stars, but that these motions sometimes increase at the upper levels of the atmosphere. An inspection of the shape of the curve of growth obtained for any particular star enables the astronomer to draw conclusions with regard to this distribution of turbulent motions with height. A.

523.877

6004. The vibration stability and autovibration of stars. D. A. FRANK-KAMENETSKIĬ. *Dokl. Akad. Nauk, SSSR,* **77** (*No.* 3) 385–8 (1951) *In Russian.*

Theoretical. The conditions for damping or auto-excitation of the vibration of stars are derived. For a

spherically symmetrical case the equation is $\Delta W = \int_M dM \oint (1 - T_e/T)(\varepsilon - dH/dM)dt$ where ΔW is the change in vibrational energy during a cycle; ε the rate of energy emission per unit mass; H the total heat flow through a spherical surface enclosing a mass M; T the temp.; T_e the temp. in a state of vibration equilibrium and t the time. The equilibrium is stable if $\Delta W < 0$, unstable for $\Delta W > 0$, while for $\Delta W \to 0$, there will be autovibrations. Terms are introduced into this equation for the production (in stages by nuclear reactions) and emission of heat. By means of the equation thus derived it is possible to explain: aperiodic stability, the development of vibrational instability for low central temps., and the final limiting vibration amplitude, if it is assumed that the basic source of energy in the stars is the H_2 cycle and that the relative pulsation amplitude increases from the surface to the centre of the stars. This contrasts with the views of Cowling, *Mon. Not. Roy. Astron. Soc.*, **94,** 768 (1934); **96,** 42 (1935); Ledoux, *Astrophys. J.*, **94,** 537 (1941); and Rosseland, *Pulsation Theory of Variable Stars*, Oxford (1949). W. HUGHES

523.877

6005. Matter and energy under cosmic conditions. H. KIENLE. *Naturwissenschaften*, **38** (*No.* 4) 92–100 (1951) *In German.*

523.877

6006. The connection between the adiabatic and radiative zones in stellar atmospheres. C. PECKER. *C.R. Acad. Sci., Paris*, **232,** 1065–6 (*March* 12, 1951) *In French.*

A continuation of previous work. See Abstr. 5052–3 (1951). D. R. BARBER

523.877 : 536.2

Thermal conductivity of dense matter. *See Abstr.* 6164

525.35

6007. On the concomitant displacements of the instantaneous axis of rotation and of the instantaneous principal axis of inertia of the earth. A. HUAUX. *Bull. Acad. Roy. Belge Cl. Sci.*, **37** (*No.* 1) 53–5 (1951) *In French.*

An approximate calculation is made of the displacement of the instantaneous inertial pole due to displacement of air masses. M. W. OVENDEN

525.35

6008. The annual displacement of the axis of rotation of the earth with respect to the terrestrial globe, in relation to an annual oscillation of the instantaneous principal axis of inertia of the earth. P. J. MELCHIOR AND A. HUAUX. **A new method of analysis of the movement of the pole at the surface of the earth.** P. J. MELCHIOR. **The concomitant displacements of the instantaneous axis of rotation, and inertia of the earth.** A. HUAUX. *Bull. Acad. Roy. Belge Cl. Sci.*, **37,** 155–85 (*Feb.*, 1951) *In French.*

Three complementary papers describing the results of an analysis, by two different methods, of some factors which influence the observed annual displacement of the earth's axis of rotation. D. R. BARBER

525.35

6009. Variations in the length of the day. A. L. LAWFORD AND V. F. C. VELEY. Letter in *Nature, Lond.*, **167,** 684 (*April* 28, 1951).

Recomputation of the increment in the total moment of inertia of the oceans gives a max. value, $1{\cdot}6 \times 10^{36}$ g/cm^2 at beginning of Feb., and in phase with the seasonal change in length of day [see Abstr. 4068 (1951)]. The cumulative time-effect is *c.* 0·01 sec, i.e. > 15% of obsd. total effect. D. R. BARBER

525.35 : 529.786

6010. The phase of the earth's (periodic time) error. A. SCHEIBE AND U. ADELSBERGER. *Z. Phys.*, **129** (*No.* 3) 233–45 (1951) *In German.*

The mean daily rates of the P.T.R. quartz clocks between 1934 and 1944 are used to plot an error curve of the earth in terms of a "mean quartz time." The results are extended to 1949 by using the Greenwich and B.I.L. observations and there is some evidence that the maximum of the error curve has changed systematically from July to May. Error formulae are given containing two periodic terms the mean amplitudes of which are 0·064 sec and 0·008 sec. L. ESSEN

526.1

6011. I. The complete determination of the local perturbations of the gravity field from torsion balance measurements with an example of the calculation (ordnance survey map of Weddingstedt i. Holstein). II. The physical law of the form of the figure of the earth (theory of the standard form of the earth). H. HAALCK. *Dtsch. Akad. Wiss. Berlin, Veröff. Geodät. Inst. Potsdam, No.* 54, 52 *pp.* (1950) *In German.*

Part I contains a discussion of theory and practical method (finite difference approximation) of calculating the local anomalies of the derivatives $W_z(= g)$, W_{zz} and W_{zzz} of the gravitational potential W from the quantities W_{xz}, W_{yz}, W_{xy} and ΔW measured by the torsion balance. The methods are illustrated by application to an area of about 122 km^2 containing approximately 800 torsion balance stations and the local variations of W_z, etc., and of the geoid are related to the geological structure. Approximate formulae in terms of the variation of W_{zzz} are given for the least depth at which the mass causing the local variations can lie. Part II is a discussion of the theory of the figure of the earth including terms of the order of the square of the ellipticity, some of which the author believes have been neglected in previous work. The resulting expression for the value of gravity on the surface of the International Ellipsoid differs from the international gravity formula by the substitution of $-8{\cdot}7 \times 10^{-6}$ for $-5{\cdot}9 \times 10^{-6}$ as the coefficient of $g_0 \sin^2 2\phi$ (g_0 value of gravity at equator, ϕ geographical latitude). A. H. COOK

526.23

6012. The 24 m interference comparator of the Potsdam Geodetic Institute. F. MÜHLIG. *Dtsch. Akad. Wiss. Berlin, Veröff Geodät. Inst. Potsdam, No.* 2, 50 *pp.* (1949) *In German.*

An instrument for standardizing invar tapes for

geodetic base measurements in terms of the red Cd line. The distance between mirrors 12·5 cm apart is compared with the distance between the mirrors of a Fabry–Perot etalon by establishing interference between white-light beams which have undergone one reflection at the 12·5 cm mirrors and two reflections at the etalon. A wedge is inserted into the combined beams to produce white-light fringes and the difference between the longer interval and twice the shorter interval is equal to the thickness of the wedge at the point where the white-light fringes occur. Similarly the 12·5 cm interval is compared with a 1 m interval, that with a 6 m interval and the latter with the 24 m interval. The length of the etalon and the thickness of the wedge are obtained in terms of the red Cd line. The apparatus is arranged so that for convenience in field work the comparisons between the different stages can be made simultaneously, and with two observers the etalon can also be standardized at the same time. The influence of optical aberrations is discussed, the use of the instrument is described and some measurements are reported. A. H. COOK

526.5

6013. Theory of errors and the adjustment of chains of diamond-shaped figures in radial triangulation. K. REICHENEDER. *Dtsch. Akad. Wiss. Berlin, Veröff. Geodät. Inst. Potsdam, No.* 1, 98 *pp.* (1949) *In German.*

A study of chains of radial triangulation in which vertices lying on a straight line are connected by sights taken on neighbouring vertices and on auxiliary points lying on either side of the line, a method used especially in aerial survey. Most of the work is concerned with figures in which the angles are 90° or 45° and either bearings or angles subtended by two stations at a third are observed; the equations of condition, the normal equations and formulae for the co-ordinates are developed. The weights of the co-ordinates and the lengths of the sides are obtained from solutions of a difference-equation both for finite and infinite chains and the effects of the conditions imposed by base measurements and by closure of the chain on fixed points are discussed. The treatment of networks in which the angles are not 90° or 45° is considered. A. H. COOK

PHYSICS 53

53.081

6014. A unit of wave-number. C. CANDLER. Letter in *Nature, Lond.*, **167**, 649 (*April* 21, 1951).

The name "Rydberg" is suggested for the unit cm^{-1}. S. WEINTROUB

FUNDAMENTALS 530.1

530.12

6015. 50 years of theory of relativity. H. WEYL. *Naturwissenschaften*, **38** (*No.* 4) 73–83 (1951) *In German.*

530.12

6016. A strange feature of Einstein's most recent generalized field theory. G. BANDYOPADHYAY. Letter in *Nature, Lond.*, **167**, 648–9 (*April* 21, 1951).

It is claimed that static symmetric solutions can be derived from Papapetrou's solutions [Abstr. 4454 (1949)] of Schrödinger's unitary field equations. Einstein's equations then imply that $em = 0$, where e and m are parameters interpreted as the charge and mass of a particle. R. A. NEWING

530.12 : 531.18

6017. A problem relating to a disk rotating in a Galilean system. A. METZ. *C.R. Acad. Sci., Paris*, **232**, 1185–7 (*March* 19); 1340–2 (*April* 2, 1951) *In French.*

Motions in opposite senses round the disk are described in terms of an inertial frame of reference.

R. A. NEWING

530.12 : 531.18

6018. The clock paradox in relativity theory. W. H. MCCREA. Letter in *Nature, Lond.*, **167**, 680 (*April* 28, 1951).

Two observers R, M are initially at rest; R observes M to move away with uniform velocity, to come to rest and then to return. M's account of the motion is found to differ from R's, and hence there is no time-dilation paradox. R. A. NEWING

530.12 : 531.51

6019. Studies in the non-symmetric generalization of the theory of gravitation. I. E. SCHRÖDINGER. *Commun. Dublin Inst. Adv. Stud., Ser. A, No.* 6, 28 *pp.* (1951).

The field equations are solved for weak fields. Given a weak Maxwellian field, the gravitational field can be found by quadratures. It is entirely different from what older theories would let one expect. Moreover, to Maxwell's equations a condition for the four-current is added, viz. that it has to be the gradient of an invariant which satisfies D'Alembert's wave equation. Several possible analogues of the matter tensor are discussed and computed for weak Maxwellian fields, including charges. The approximation reached here is insufficient and will have to be extended in order to reveal the reaction of the fields on their sources. A.

530.145

6020. Changes of state caused by the process of measurement. G. LÜDERS. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 322–9 (1951) *In German.*

A treatment by v. Neumann (*Mathematische Grundlagen der Quantenmechanik*, 1932) is critically discussed and an alternative treatment introduced, which permits of a fuller discussion of the concept of the compatibility of measurements. E. P. WOHLFARTH

530.145

6021. On the formalism of linear field theories. H. STEINWEDEL. *Z. Naturforsch.*, **6a**, 123–33 (*March*, 1951) *In German.*

For linear generalizations of classical electrodynamics such as those of Bopp [Abstr. 1620 (1946)] and Feynman [Abstr. 1681 (1949)], the field equations

and their general solutions (and in particular the static potential) are studied. The methods used are applicable to charged fields and fields of different spin: the well-known regularization postulates follow from the requirement that the theory be divergence-free.

R. H. DALITZ

530.145 : 538.3

6022. On the elimination of divergences from quantum electrodynamics. S. N. GUPTA. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 426–7 (*April*, 1951).

The renormalization programme can be carried through more symmetrically and simply by including an extra term in the Lagrangian of the Maxwell field.

G. J. KYNCH

530.145

6023. On the relativistic invariance of the quantization in the meson pair theory. O. BRULIN AND S. HJALMARS. *Ark. Fys.*, **3**, *Paper* 7, 83–5 (1951).

The relativistic invariance in the author's previous papers [Abstr. 729, 1491 (1949)] is established by including small extra terms into the matrix equations of the mesons as originally suggested for the Dirac electron by Heisenberg and Pauli.

G. J. KYNCH

530.145

6024. Restriction of possible interactions in quantum electrodynamics. A. PETERMANN AND E. C. G. STUECKELBERG. Letter in *Phys. Rev.*, **82**, 548 (*May* 15, 1951).

The necessary and sufficient condition on the form of interaction energy densities to permit the satisfactory replacement of "free" propagation functions S_F, D_F.. in the S-matrix by the "effective" functions S_F', D_F'.. is stated. For particles of spin 0, $\frac{1}{2}$, 1, all allowed interactions are enumerated.

R. H. DALITZ

530.145

6025. A variational method for inelastic collision problems. B. L. MOISEIWITSCH. Letter in *Phys. Rev.*, **82**, 753 (*June* 1, 1951).

A generalization of Hulthen's variational method has been derived, which is suitable for calculating the inelastic scattering of electrons by atoms.

G. J. KYNCH

530.145 : 538.3

6026. The reciprocity theory of electrodynamics. H. S. GREEN AND K. C. CHENG. *Proc. Roy. Soc. Edinb., A*, **63** (*Pt II*) 105–38 (1951).

Represents the application of the Principle of Reciprocity [see Abstr. 5937 (1949)] to the outstanding problems of classical and quantum electrodynamics. The first step consists in the formulation of a reciprocally invariant Lagrangian function for a system of electrons in interaction with the electromagnetic field. A study is made of the unaccelerated motion of an electron, and this is subsequently extended to embrace the problem of an electron in arbitrary motion. It is found that the usual difficulties of classical electrodynamics do not appear. The methods of the earlier paper are applied to the derivation of the Hamiltonian energy of electron and field, and this enables a quantized formulation of the theory to be given, which also does not lead to the usual divergence difficulties.

A.

530.145 : 538.3

Elimination of divergencies from classical electrodynamics. *See Abstr.* 6358

530.145

6027. Note on the general theory of scattering. M. I. GOLDBERGER. Letter in *Phys. Rev.*, **82**, 757 (*June* 1, 1951).

A new presentation of the theory is given, leading to two systems of integrals equations, one of them the Heitler equation. The procedure has the advantage that it starts from the state functions of the separated systems and can be derived by a variational principle.

G. J. KYNCH

530.145

6028. Geometrical introduction of elementary particles in unitary affine theory. J.-P. VIGIER. *C.R. Acad. Sci., Paris*, **232**, 1187–9 (*March* 19, 1951) *In French.*

Particle fields are represented as infinitesimal deformations of Euclidean space-time, and Schrödinger's affine theory [Abstr. 1761 (1948)] is used to determine the corresponding Lagrangians. The asymmetric part of the deformation is shown to give particles with spin 1, while the symmetric part gives two fields corresponding to particles with spins $\frac{1}{2}$ and zero.

R. A. NEWING

530.145

6029. First-order first-integrals in Dirac theory. The necessity of the operator $\partial/\partial t$ in time-dependent first-integrals. Forms of the first-integral operator. R. FAURE. *C.R. Acad. Sci, Paris*, **232**, 1469–71 (*April* 16, 1951) *In French.*

530.145

6030. On the variational derivation of the general equations describing particles of arbitrary spin and multiple mass. R. POTIER. *C.R. Acad. Sci., Paris*, **232**, 1538–40 (*April* 23, 1951) *In French.*

Related to equations discussed previously [Abstr. 5938 (1949)].

J. R. MADDOX

530.145

6031. On the wave-equations of particles of multiple masses. R. POTIER. *C.R. Acad. Sci., Paris*, **232**, 1647–9 (1951).

Solutions are obtained in a simple manner, of the equations given earlier (preceding Abstr.).

G. J. KYNCH

530.145

6032. On the calculation of the current 4-vector in the theory of particles of arbitrary spin and multiple masses. R. POTIER. *C.R. Acad. Sci., Paris*, **232**, 1736–8 (*May* 7, 1951) *In French.*

Using the Lagrangian the current vector is found for the various representation of particles which occur in the theory proposed (preceding Abstr.).

G. J. KYNCH

530.145

6033. First integral of the first time-dependent order. Study of two particular cases. Significance of the matrices α_1, α_2, α_3; the operator $(h/2\pi i)(\partial/\partial t)$ plays a rôle analogous to those of the operators $(h/2\pi i)(\partial/\partial qi)$. R. FAURE. *C.R. Acad. Sci., Paris*, **232**, 1738–40 (*May* 7, 1951).

530.145

6034. On the neutron-proton interaction. I. Y. ODA, J. SANADA AND S. YAMABE. *Sci. Pap. Osaka. Univ.*, *No.* 15 (1949).

Repeats many well-known arguments concerning the deuteron ground state, photodisintegration and n–p scattering based on Yukawa potential. E. P. GEORGE

530.145

6035. An algebraic theory of the density matrix. I. K. HUSIMI AND T. NISHIYAMA. *Progr. Theor. Phys.*, **5**, 909–19 (*Nov.–Dec.*, 1950).

The density matrix for n electrons at temperature T is reduced explicitly into "reduced density matrices" corresponding to various classes of the symmetric group. Also, for $T=0$, the Hartree–Fock equations are derived for n Fermi particles with binary interactions, from the minimum energy principle.

R. H. DALITZ

530.145

6036. Remarks on Bethe's neutral theory of nuclear force. M. SUGAWARA. *Progr. Theor. Phys.*, **5**, 920–30 (*Nov.–Dec.*, 1950).

The applicability of a neutral meson potential for low-energy nucleon phenomena is investigated, when the singular tensor potential is modified to an acceptable Yukawa singularity. Only a pseudoscalar theory even approaches a reasonable representation of the experimental data, previous agreement found by Bethe [*Phys. Rev.*, **57**, 390–413 (*March* 1, 1940)] with a vector theory being dependent on the particular cut-off chosen. R. H. DALITZ

530.145

6037. Factorization ladders and eigenfunctions. G. F. D. DUFF. *Canad. J. Math.*, **1** (*No.* 4) 379–96 (1949).

Conditions are obtained for wave-equations when operators leading to ladders of normalized eigenfunctions are to exist. Two types of ladder are found, in one case finite and in the other infinite. Each type is further classified as reducible or not, according as the recurrence relation can be transformed into a special simple form or not. Irreducible problems of one type are related to reducible problems of the other. Formulae are given for the normalized eigenfunctions of the reducible problems [see also Abstr. 1702 (1949)]. G. J. KYNCH

530.145

6038. On the unique determination of the nuclear potential between charged nucleons with the aid of scattering experiments. P. JAUHO. *Ann. Acad. Sci. Fennicae, Ser. A* 1, *No.* 80, 43 *pp.* (1950).

It is shown that the potential between two protons is uniquely determined by scattering experiments. An *ab initio* formulation of the problem is given, with a full mathematical analysis [see also Abstr. 1704 (1949)]. W. J. SWIATECKI

530.145

6039. Method for the study of perturbations of limited duration. G. RIDEAU. *C.R. Acad. Sci., Paris*, **232**, 1338–40 (*April* 2, 1951) *In French.*

Formulae are obtained for the calculation of transition probabilities using the method of Schwinger and Lippmann [Abstr. 8498 (1950)]. G. J. KYNCH

530.145

6040. On the conservation of energy in quantum mechanics. G. RIDEAU. *C.R. Acad. Sci., Paris*, **232**, 1409–11 (*April* 9, 1951) *In French.*

Earlier results (preceding Abstr.) are used to establish the precise conditions for conservation.

G. J. KYNCH

530.145.6 : 531.3

6041. The correspondence between classical and wave mechanics. R. FAURE. *J. Math. Pures Appl.*, **28**, 193–285 (1949) *In French.*

The wave equation studied corresponds to a mechanical system whose kinetic energy and potential energy are given functions of generalized co-ordinates and velocities; in the case of a vector potential giving the effect of an electromagnetic field is included. The substitution $\psi = a \exp(i\phi/h)$ leads to 2 equations for a and ϕ. In the lowest order in h, the geometrical-optical limit, the classical Hamilton–Jacobi equation is obtained. The paper is concerned with studying, from this point of view, the relation between the first integrals of the classical problem and constants of the motion for the quantum-mechanical problem.

MATHEMATICAL REVIEWS

530.145.6

6042. Diverging potentials and the virial theorem. A. ORE. Letter in *Nature, Lond.*, **167**, 728–9 (*May* 5, 1951).

An erroneous conclusion derived in Abstr. 4117 (1951) regarding the non-existence of bound states in a $r^{-n}(n \geqslant 2)$ potential is rectified in view of K. M. Case [Abstr. 2393 (1951)]. W. J. SWIATECKI

530.145.6

6043. Maximum rate of wave function amplitude change. R. LANDAUER. Letter in *Phys. Rev.*, **82**, 549 (*May* 15, 1951).

An upper bound for the modulus of a Schrödinger wave-function at any point is obtained, when its value at some turning-point is known. R. H. DALITZ

530.145.6

6044. Energy levels of a vector particle in a pure Coulomb field. K. M. CASE AND A. M. L. MESSIAH. Letter in *Phys. Rev.*, **82**, 563 (*May* 15, 1951).

The effect of a prescribed phase at the origin of a wave-function which is a solution of a Schrödinger equation with singular potentials is discussed [Abstr. 2393 (1951)]. P. T. LANDSBERG

530.162 : 532.73

The statistical mechanical theory of solutions. I. *See Abstr.* 6071

530.162 : 533.15 : 533.7

Gaseous diffusion as a random process. *See Abstr.* 6077

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.224

6045. Finite deflections of a cantilever-strut. R. A. BETH AND C. P. WELLS. *J. Appl. Phys.*, **22**, 742–6 (*June*, 1951).

A cantilever-strut is an originally uniform thin rod clamped or "built-in" at one end and acted on by an

arbitrary force at the other end. The arbitrary force and the angle it makes with the tangent to the clamped end of the rod are regarded as independent variables. The problem of finding the deflection co-ordinates of the loaded end of the rod, the tangent angle of the loaded end, and the strain energy of bending in the rod is solved in terms of a newly defined function that satisfies a nonlinear partial differential equation. Solutions are given in series form. Since the cantilever-strut is a segment of an inflectional elastica, the classical elliptic integral solution is also outlined for comparison with the more direct series solution of the problem. A.

531.259 : 535.551

6046. Measurement of the curvature of stress trajectories in photoelastic models. A. F. C. BROWN. *Brit. J. Appl. Phys.*, **2**, 138–40 (*May*, 1951).

The use of Jessop's extension of the Lamé–Maxwell equations for separating the principal stresses in a three-dimensional photoelastic problem depends for its accuracy on a precise knowledge of the curvature of the stress trajectories crossing the line along which the integration process is carried out. A method of measuring these curvatures more accurately than has been possible before is described and an example is given of the application of the method to a particular frozen stress problem. A.

531.261

6047. On the discontinuity in the derivatives of gravitational potential at a surface of discontinuity of density. T. MANACORDA. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 42–8 (*Jan.*, 1951) *In Italian.*

531.3

6048. Synthesis of mathematical machines and real objects. G. L. POLISAR. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 4) 711–14 (1950) *In Russian.*

This article is directed to proving that, for the purpose of investigating the dynamic principles of complex systems, it is possible, in theory, to combine mathematical machines, working by intermittent action, with the objects under investigation.

J. CLEUGH

531.35

6049. The temperature barrier of high altitude, long distance missiles. G. A. CROCCO. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 97–103 (*Feb.*, 1951) *In Italian.*

The trajectory of a missile may reach the inversion-of-temperature zone. Beyond 300 km above the earth the temperature reaches thousands of degrees. First, the absolute trajectory is calculated assuming the earth to be stationary; ballistic corrections are then made for the rotation of the earth. Another simplification is to treat the trajectory as consisting of two separate curves, namely from the starting-point up to where the propellant and the reactive thrust are exhausted, and then to the end of the trajectory. The velocity of a missile which is not to leave the terrestrial gravitational field must be $< \sqrt{(2g_0R)}$ where g_0 is the gravity at the surface of the earth at the launching point and R is the radius of the earth if it is taken as a sphere. The trajectory in this case will be part of an ellipse that has one focus at the centre of the spherical earth and that is generally described by a polar equation of the form $r = \frac{p}{1 + e \cdot \cos\theta}$ where r and θ are the polar co-ordinates. W. SUMMER

531.4

6050. Studies on friction. I. About a newly designed apparatus for friction. Y. KENTARO. *J. Mech. Lab., Tokyo*, **4**, 309–13 (*Dec.*, 1950) *In Japanese.*

"Stick-slip" phenomena were at one time believed to be capable of explaining the nature of friction satisfactorily, but recently it is pointed out the phenomena are only due to relaxation oscillation in the system of the mass of a test piece and measuring springs. Study of resistance measured at the initial instance of slipping may lead to the discovery of the nature of statical friction and the study of the slip length to that of kinetic friction. Existing measuring apparatus is reviewed and a new apparatus designed for the analysis of measured data is expounded. A.

531.571

6051. Stability of flow in a rocket motor. H. I. ANSOFF AND M. YACHTER; D. F. GUNDER AND D. R. FRIANT. Letters in *J. Appl. Mech.*, **18**, 114–16 (*March*, 1951).

Comments on the mathematical analysis in the paper by D. F. Gunder and D. R. Friant [Abstr. 103 (1951)], with reply by the authors. A. C. CLARKE

MECHANICAL MEASUREMENTS 531.7

531.715.2 : 535.8

Some points in the design of optical levers and amplifiers. *See Abstr.* 6158

531.751.1

6052. The stability of analytical weights, particularly in chemical laboratories. P. H. BIGG AND F. H. BURCH. *Brit. J. Appl. Phys.*, **2**, 126–31 (*May*, 1951).

Analytical weights of various modern materials, including a large proportion of plated types, have been subjected to accelerated corrosion and stability tests in five representative chemical laboratories. As regards stability of mass there was little to choose between the weights of austenitic stainless steel (25% Cr, 20% Ni), non-magnetic nickel-chromium (80% Ni, 20% Cr), and the plated weights having a nominal thickness of plating of about 0·015 mm or more; some weights of specially highly-polished stainless steel were, however, slightly superior. Chromium-plated weights retained their appearance better than any except perhaps those of highly-polished stainless steel and nickel-chromium, but they are open to the objection that the underlying nickel is slightly magnetic. No kind of weight appeared to be much more suited to one laboratory than to another. Lead should not be used for the adjustment of weights whether they are likely to be exposed to corrosive

atmospheres or not. The paper also includes information on the behaviour of weights of various materials under good conditions. A.

531.787.2

6053. A membrane manometer with secondary air transmission. C. P. Luck. *J. Sci. Instrum.*, **28**, 173–6 (*June*, 1951).

An instrument, suitable for routine physiological work, having a secondary air transmission recording system, on the principle used earlier by Fredericq. The manometer is of Perspex and stainless steel, is 4 cm long, 2 cm wide and 3 cm high, weighing when filled 15 g. The natural frequency of the instrument when the recording lever moves 1 mm to every 4 mm of Hg change in pressure is 20 double vibrations/sec. When using the Goetz method of recording the frequency is 45 vibrations/sec. It allows free movement of the animal without introducing errors into the record. A.

MECHANICS OF FLUIDS 532

532.13

6054. Mechanical properties of substances of high molecular weight. IX. Non-Newtonian flow and stress relaxation in concentrated polyisobutylene and polystyrene solutions. F. W. Schremp, J. D. Ferry and W. W. Evans. *J. Appl. Phys.*, **22**, 711–17 (*June*, 1951).

A coaxial cylinder apparatus serves to measure the apparent viscosity of a concentrated polymer solution at various shearing stresses and to follow the relaxation of stress after sudden cessation of flow. The dependence of rate of strain (γ') on shearing stress (Σ) can be represented by the equation $\gamma' = k_1 \sinh k_2\Sigma$. The constant k_2 is almost independent of temperature, and decreases with increasing concentration. The course of the stress relaxation depends on the steady state value of γ' preceding cessation of flow. By assuming a logarithmic distribution function Φ of elastic mechanisms which are relaxed by hyperbolic sine flow mechanisms, it can be shown that $\Phi \simeq -(d\Sigma/d \log t)/2{\cdot}303k_1t2 \tanh^{-1}\{(\gamma'/k_1)/(1 + [1 + (\gamma'/k_1)^2])\}^{\frac{1}{2}}$, where t is the elapsed time. Values of Φ obtained from this equation are essentially independent of the rate of shear. The reduced distribution function, $\Phi_r = \Phi T_0/Tc$, plotted against the logarithm of the reduced relaxation time, $\tau_r = \tau cT/T_0\eta$, where T is the absolute temperature, $T_0 = 298°K$, c is the concentration in g/cm^3, and η the viscosity at zero stress, is independent of temperature and concentration over the ranges studied for each of three polymer samples. A.

532.13

6055. Mechanical properties of substances of high molecular weight. X. The relaxation distribution function in polyisobutylene and its solutions. J. D. Ferry, E. R. Fitzgerald, M. F. Johnson and L. D. Grandine, Jr. *J. Appl. Phys.*, **22**, 717–22 (*June*, 1951).

Previous twin transducer measurements of the dynamic rigidity and viscosity of a polyisobutylene sample of viscosity-average mol. wt 1·2 million have been extended over a wider temperature range, and previous wave propagation data on solutions of this polymer in xylene have been extended by transducer measurements at lower concentrations. Values of the relaxation distribution function are derived from all these data and are compared with values obtained from stress relaxation measurements on solutions of the same polymer in decalin, as well as stress relaxation data of Andrews and Tobolsky on solid polyisobutylene and dynamic measurements on butyl rubber from several sources. When reduced to a common reference state at 25°c by the assumption that all relaxation processes depend identically on temperature, the data for solid polyisobutylene provide a picture of the distribution function over eleven cycles of logarithmic time. It appears to have a plateau from 0·1 to 10^4 sec with a sharp rise at shorter times and a sharp drop at longer times. From 10^{-5} to 0·1 sec the functions for polyisobutylene and butyl rubber are similar in shape, the latter being somewhat higher. When data for polyisobutylene solutions from 5 to 25% concentration are reduced to the reference state of the solid polymer by the assumption that all relaxation processes depend identically on concentration, a single distribution function is obtained which from 10 to 10^6 sec is similar in shape to that derived from direct measurements on the solid polymer but lies somewhat below it. A.

532.5 : 621.317.329

6056. Further development of fluid mappers. A. D. Moore. *Trans Amer. Inst. Elect. Engrs*, **69** (*Pt II*) 1615–24 (1950).

The practical details of the construction and use of fluid mappers are described and some improvements in technique are mentioned. See also Abstr. 76 (1950). H. J. H. STARKS

532.51

6057. Critical regimes of flows with density stratification. A. Craya. *Tellus*, **3**, 28–42 (*Feb.*, 1951).

First discusses the analogy between flow in an open channel and either internal or surface currents in large bodies of fluid and shows that the concept of the critical regime is generally applicable to such cases. The critical regime of gravity currents due to density stratification is then examined in terms of both the momentum principle and the somewhat simpler energy principle; contrary to the case of open-channel hydraulics, the two principles result in different flow criteria. In the case of surface currents it is shown that, for constant piezometric or energy level at the surface, the critical regime corresponds to a velocity distribution which reaches a maximum some distance from the surface. A.

532.527

6058. On Ertel's vorticity theorem. C. A. T. Truesdell. *Z. angew. Math. Phys.*, **2** (*No.* 2) 109–14 (1951).

The kinematical foundation of this equation based on the Lagrange–Beltrami equation is shown, and its generalization to viscous compressible fluids is derived.

Applications to incompressible fluids, non-viscous fluids and vorticity in the flow behind curved shock are given. E. H. DOCK

CAPILLARITY 532.6

532.61.08

6059. A new method of measurement of the surface tension of viscous liquids. P. R. JOHNSON AND R. C. L. BOSWORTH. *J. Proc. Roy. Soc., N.S.W.*, **83** (*No.* 3) 164–9 (1949).

Most methods of surface tension measurement are unsuitable for very viscous liquids, e.g. molasses, because of the long time required to attain equilibrium. In the present method a sessile drop is used and the images of two distant light sources reflected in the surface are photographed and from the geometrical relation of sources, camera and images it is possible to calculate the radius of curvature (b) of the drop at its vertex. The surface tension (γ) can then be obtained from the formula $\gamma = gdr^3/6(b - r)$, where g = acceleration due to gravity, d = density, r = equatorial radius of drop. This approximate equation holds with an accuracy of $\pm 1\%$ for all droplets below a certain size which depends on density and surface tension. For molasses the limiting dia. is 0·64 cm and for Hg it is 0·56 cm.

J. IBALL

532.61.08 : 532.69 : 541.18

6060. Fundamental studies on interfacial tensions in flotation. II. M. WADA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 425–34 (*Dec.*, 1949).

See Abstr. 8534 (1950) for Part I. The time-variation of surface tension of cineol solutions, and surface activity and orientation are considered.

R. F. BARROW

532.61.08 : 532.69 : 541.18

6061. Fundamental studies on interfacial tensions in flotation. III. Tilting-plate method of determining contact angle and the wetting tension of aqueous solutions of frothers for paraffin-wax. M. WADA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 102–26 (*Feb.*, 1950).

532.61.08 : 532.69 : 541.18

6062. Fundamental studies on interfacial tensions in flotation. IV. Suspended-plate method of determining wetting tension and the time variation of wetting tension of glass at water-air interface. M. WADA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 128–49 (*Feb.*, 1951).

532.612

6063. Study of boundary layer phenomena. Application of sapoalbin. R. LOOS. *Verh. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 34) 126 *pp.* (1950) *In Dutch.*

The theory and technique of the vertical adhesion plate method for the measurement of surface tension (S) and interfacial tension (I), and the validity of the Gibbs formula, are discussed in detail. The method is satisfactory as a standard and absolute method. Applications are described to solutions of sapoalbinic acid and of its Na salt, and to the measurement of the I between H_2O and C_6H_6, CCl_4, $CHCl_3$ and C_6H_5Cl. The observed fairly rapid initial decrease in S with time, reaching an approx. const. val., is due to diffusion of effects. The relation between the reduction in S on addition of salts (concn. of the order of 10^{-3} equiv./l.) to solutions of sapoalbinic acid, and the log of the salt concn., is linear for the alkali metal chlorides, but with $Al(NO_3)_3$ it is represented by two straight lines at an angle. The relationship between S and pH value is approx. linear between pH 4 and 7. J. GRANT

532.612.4

6064. Surface tension of liquid metals. D. V. ATTERTON AND T. P. HOAR. Letter in *Nature, Lond.*, **167**, 602 (*April* 14, 1951).

The assessment of surface tension data from density measurements and the importance of this data in the sand casting of metals of high atomic weight are considered. H. P. MYERS

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 536.7

6065. Ultrasonic velocity and adiabatic compressibility of athermic or ideal liquid mixtures. F. DANUSSO. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 235–42 (*March*, 1951) *In Italian.*

An extension of earlier work [Abstr. 4150 (1951)] to simple liquid mixtures. Formulae are deduced mathematically relating the molecular adiabatic compressibility (B) with the number of molecules in the compressed system and the rate of increase of the vol. (V) with respect to pressure at constant entropy. Experimental results obtained for B from measurements of the density and the ultrasonic velocity are compared with the calculated results for athermic mixtures of various hydrocarbons, aliphatic alcohols and chlorinated organic compounds; they demonstrate the additive character of V. J. GRANT

532.7 : 539.152.1

6066. Nuclear magnetic resonance fine structure in liquids. H. S. GUTOWSKY AND D. W. MCCALL. Letter in *Phys. Rev.*, **82**, 748 (*June* 1, 1951).

Splitting of both the F^{19} and P^{31} resonance lines in liquid $POCl_2F$, etc., suggests restricted molecular rotation. D. H. WHIFFEN

532.71

6067. Theory of high polymer solutions. I. General form of second osmotic coefficient. A. ISIHARA AND T. HAYASHIDA. *J. Phys. Soc. Japan*, **6**, 40–5 (*Jan.–Feb.*, 1951).

An attempt at a better understanding of the behaviour of macromolecules in solution. The second virial coefficients are calculated which appear when the osmotic pressure of high polymer solutions is expanded in the power series of concentration c:

$\pi/RTc = 1/M_2 + A_2c + A_3c^2$, where M_2 is molecular weight of solute, R gas constant and T absolute temperature. T. C. TOYE

532.71

6068. Theory of high polymer solutions. II. Special forms of second osmotic coefficient. A. ISIHARA AND T. HAYASHIDA. *J. Phys. Soc. Japan*, **6**, 46–50 (*Jan.–Feb.*, 1951).

Preceding Abstr. part I. The second osmotic coefficient A_2 in the power series is calculated for various special cases. T. C. TOYE

532.71 : 537.362

6069. Osmosis in a high frequency electric field. Z. LÁSZLÓ. Letter in *J. Chem. Phys.*, **19**, 800–1 (*June*, 1951).

Experiments are described for osmosis under a.c. voltage of 380 kc/s with a pierced glass diaphragm and with a porous glass filter. It is concluded that the field may exert no influence on the osmosis, since in the vicinity of the filter the Brownian motion of the molecules decreases with increasing frequency. H. H. HODGSON

532.712

6070. Sedimentation equilibrium in concentrated polymer solutions. M. WALES. *J. Appl. Phys.*, **22**, 735–9 (*June*, 1951).

It has been shown that sedimentation equilibrium can be obtained in polymer solutions of concentration as high as 20% by weight. This equilibrium has been approached from both sides, with identical results. The virial coefficients for the osmotic pressure may be calculated from experiments of this kind. The results are in good agreement with the osmotic pressure data of other investigators for polystyrene in butanone and polyvinyl acetate in butanone. A.

532.73 : 530.162

6071. The statistical mechanical theory of solutions. I. J. G. KIRKWOOD AND F. P. BUFF. *J. Chem. Phys.*, **19**, 774–8 (*June*, 1951).

A general statistical mechanical theory of solutions is developed with the aid of the theory of composition fluctuations in the grand canonical ensemble. It is shown that the derivatives of the chemical potentials and osmotic pressure with respect to concentrations, the partial molar volumes, and compressibility may be expressed in terms of integrals of the radial distribution functions of the several types of molecular pairs present in the solution. Explicit coefficients of a q-fraction expansion of the thermodynamic variables are presented in a detailed treatment of the two component systems. A.

MECHANICS OF GASES 533

533.2

6072. The sudden impact of a moving gas column against one at rest. E. MEYENFISCH. *Schweiz. Arch. angew. Wiss. Tech.*, **17**, 119–26 (*April*, 1951) *In German.*

Hugoniot's analytical treatment of the impulse of a pressure wave upon a column enclosed and at rest in a tube is briefly discussed (J. de l'Ecole Polytechnique, Paris, No. 58), and a general treatment of the sudden impact of one moving column of gas upon another at rest is given, 5 cases being considered according to the relative pressure conditions in the two columns before or after the impact. A complete analytical solution of conditions in the two gas columns is possible only in two cases by application of the principles of the conservation of mass, impulse and energy, but a graphic solution of all five cases is possible and is given. J. S. G. THOMA

533.4

6073. A new type of mercury barometer with an optical system for reading. L. MARTINELLI. *Atti Fond. "Giorgio Ronchi,"* **6**, 90–3 (*April*, 1951) *In Italian.*

533.5

6074. The discharge tube vacuum meter. K. HACHIYA, M. MICHIJIMA AND Z. UZAWA. *Sci. Pap. Osaka Univ., No.* 11, 8 *pp.* (1949).

The properties of the vacuum meter of the "discharge-current in a magnetic field" type have been investigated. The best shape of the electrodes is the one allowing a max. of ions to be produced by electrons colliding with the atoms of the gas. Conditions for the optimum size of the electrodes are given. The discharge current depends primarily on the number of collisions and not upon the number of electrons in the molecule. The magnetic field must be uniform over the entire length of the electrodes and should be at right angles to their axis, though deviations $< 5°$ are permissible. There is a critical (minimal) field strength which is almost independent of the current and vacuum. Vacua $< 10^{-6}$ mm Hg can be measured with good tubes and results are reproducible. A modified Geissler tube for measuring down to 10^{-2} mm Hg is described. W. SUMMER

533.6.011.5

6075. Application of relaxation methods to compressible flow past a double wedge. A. R. MITCHELL AND D. E. RUTHERFORD. *Proc. Roy. Soc. Edinb., A*, **63** (*Pt. II*) 139–54 (1951).

The relaxation technique of R. V. Southwell is shown to be applicable in certain cases to transonic problems. For a uniform stream with a low subsonic velocity impinging on a symmetrical 2-dimensional double wedge, an asymmetrical supersonic region can be isolated in the neighbourhood of the corner of the wedge, and the streamlines and the values of the Mach number within this supersonic region can be determined with the aid of relaxation methods. A.

533.6.013.22

6076. The foundation of the quantization of turbulence. K. KUSAKAWA. *J. Phys. Soc. Japan*, **6**, 86–9 (*March–April*, 1951).

In a previous paper [Abstr. 2453 (1951)] the author derived an expression for the frequency distribution of energy in quantized turbulent flow. Now, the physical significance of the quantization of turbulence is discussed on the assumption of the existence of an uncertainty between the components of velocity and position, and it is shown that the

translatory velocity of the smallest drop of fluid can be measured with experimental error, but its spin can have no physical meaning. The theory developed in the previous paper is developed more strictly, dissipation of energy of turbulence by thermal motion being taken into account. J. S. G. THOMAS

MOLECULAR THEORY OF GASES 533.7

533.7 : 533.15 : 530.162

6077. Gaseous diffusion as a random process. W. H. FURRY AND P. H. PITKANEN. *J. Chem. Phys.*, **19**, 729–38 (*June*, 1951).

It has long been known that the problem of random flights of a single molecule provides in principle a method for calculating the diffusion coefficient D_{12} for the case in which the concentration of the diffusing component is small. This method has been, in effect, an elementary and rather crude one, because correlations of speed and direction were not taken into account and, accordingly, the rather ambiguous concept of mean free path had to be given an arbitrary definition. In this paper these difficulties are overcome; an accurate treatment of gaseous diffusion is based on the random flight method. The determination of the diffusion coefficient is made to depend on the solution of an integral equation; the unknown function of this equation can be interpreted as the unambiguously defined effective mean free path, for diffusion, of molecules of given speed. The resulting value of D_{12} is the same as is obtained from the standard Enskog–Chapman treatment based on Boltzmann's equation. A.

533.72 : 534.22/.23

6078. Energy transfer by collision in benzene vapor. L. M. CHENG. *J. Chem. Phys.*, **19**, 693–7 (*June*, 1951).

The velocity and absorption of ultrasonic waves in benzene vapour were measured by means of the sonic interferometer, at frequencies of 251·44, 497·44 and 1,008·06 kc/s, within the pressure range 2 to 9·5 cm Hg, between the temperature limits 30·2°C to 37·6°C. Dispersion of the velocity, after being reduced to 30°C, ranged from 190·4 to 207·31 m/sec. The corresponding values of the specific heat C_v/R dropped from 9·45 to 3·0. Values of the molecular absorption coefficients, which are several times larger than the classical ones, are interpreted as due to the loss of vibrational degrees of freedom only. The theoretical values calculated from Kneser's method show a close agreement with the dispersion curve, but not so well with the absorption values. An improvement of fit was made by the assumption of two relaxation times, but owing to the scattering of the experimental points, it is very hard to decide which theory fits better. The value of the single relaxation time is 5×10^{-8} sec, and those from the second assumption are 2×10^{-8} and $6\cdot8\times10^{-8}$ sec. A.

533.72 : 539.132

Triple-dipole interaction. *See Abstr.* 6376

VIBRATIONS . ACOUSTICS 534

534.01 : 538.55

6079. Theory of waves and oscillations in inhomogeneous discrete structures (inhomogeneous wave filters). P. E. KRASNUSHKIN. *J. Tech. Phys., USSR*, **20**, 1065–83 (*Sept.*, 1950) *In Russian.*

Deals with chain-like structures of members representing oscillation systems with one degree of freedom. Discrete Sturm-type systems are their limiting case when the natural frequencies of all members tend towards zero. Only two limiting cases are considered, viz. loose and tight resonance coupling between elements (or members), and the intermediate range is investigated by excitation methods. For loose coupling and different natural oscillations of the members, all these natural oscillations have localized character. Tightening of the coupling leads to their subsidence according to an exponential law. At the limiting tight coupling the structure becomes periodical and all the oscillations assume collective character, i.e. the same frequency, this being a multiple degeneration process. Owing to interaction of the elements this degeneration disappears and the original frequency is split up into a band if the number of members is infinite. The weakening of the resonance coupling, i.e. a slight deterioration of periodicity, may lead to a distribution of the collective oscillations limited to some bounded intervals and there will be sections of the elements where the collective oscillations appear in the form of exponential "tails." Owing to the standing-wave nature of these oscillations the regions confining them are known as wave barriers. On weakening of the coupling between the elements the barrier regions expand at the expense of the "collectivized" elements and in the limiting case of very loose coupling the collective oscillations degenerate into local ones. B. F. KRAUS

534.152 : 535.417

6080. Vibration measurement by interferometry. C. F. BRUCE, J. A. MACINANTE AND J. C. KELLY. Letter in *Nature, Lond.*, **167**, 520–1 (*March* 31, 1951).

A brief description of the use of a stroboscope technique with multiple-beam interferometry. Experiments are described in which optical flats are mounted on the prongs of a tuning-fork and the interference fringes between them viewed with continuous and with intermittent light. Amplitudes may be measured either as a fringe broadening or as a slow periodic movement of intermittent illumination. An accuracy of $0\cdot003\mu$ is claimed. S. TOLANSKY

534.21 : 538.221

6081. Propagation of ultrasonics in ferromagnetics. S. PETRALIA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 146–51 (*Feb.*, 1951).

Longitudinal waves are propagated along a mild steel rod. When the frequency is near a transmission maximum, magnetization of the rod increases the transmitted intensity by a factor 5–6, the effect being independent of frequency. The maximum transmission frequency of the rod is slightly shifted

by magnetization. A qualitative explanation is given, based on the reduction of internal friction by magnetization. L. PINCHERLE

534.21 : 538.56

6082. Wiener–Hopf techniques and mixed boundary value problems. S. N. KARP. *Commun. Pure Appl. Math.*, **3**, 411–26 (*Dec.*, 1950).

Boundary value problems associated with the equation $\Delta u + k^2 u = 0$ in acoustics and electromagnetic theory can be reduced to the solution of Wiener–Hopf integral equations by the introduction of a Green's function. Fourier transformation of the integral equation leads to one equation between two unknown transforms, which can be solved by techniques based on the theory of functions [see J. S. Schwinger, *Fourier transform solutions of integral equations*, M.I.T. Radiation Laboratory Report]. A parallelism between this method and the classical method of separation of variables is illustrated by considering the diffraction of a plane wave by a semi-infinite screen, and other problems. Some heuristic advantages of the separation of variables procedure are indicated. A. T. PRICE

534.22 : 539.13

6083. A note on the sigma phenomenon. R. C. L. BOSWORTH. *J. Proc. Roy. Soc., N.S.W.*, **83** (*No.* 1) 39–43 (1949).

A theory is developed based on the assumption that momentum is transported by transverse acoustical vibrations. No exact comparison with experiment is possible, but an estimate of molecular volume can be obtained. J. E. CAFFYN

534.23 : 536.531

6084. Thermistors as used in ultrasonic interferometry. O. LINDSTRÖM. Letter in *Research, Lond.*, **4**, 238–9 (*May*, 1951).

The interferometer used to test liquids consists of a cylinder with a quartz plate at the base emitting ultrasound towards the free surface. Liquid is added at a constant rate and continuous records are made of the power supplied to the quartz transmitter. The power measurement is made by a thermistor which is heated by the h.f. current and the reduction of its resistance is recorded. A. C. WHIFFIN

534.23 : 536.2

6085. The contribution of thermal conductivity to the ultrasonic absorption coefficient in liquefied gases. R. T. BEYER. *J. Chem. Phys.*, **19**, 788–9 (*June*, 1951).

The contribution is computed on the basis of known experimental values of the thermal conductivity or of approximate theoretical values. The results are compared with Galt's experimental data and satisfactory agreement is obtained. A.

534.231

6086. Circulations occurring in acoustic phenomena. G. D. WEST. *Proc. Phys. Soc., Lond. B*, **64**, 483–7 (*June*, 1951).

An investigation was made, by means of smoke particles, of the movements of the air in the neighbourhood of a vibrating reed. At very low frequencies, the paths of the particles exhibit a pattern which, at first sight, resembles the lines of hydrodynamic flow. A more careful examination at sufficiently high magnification shows, however, that the particles do not move along the hydrodynamic lines but trace out small ellipses. In addition, a mass circulation of the particles is superimposed on the above motion. At low frequencies this circulation is feeble, but with increasing frequency it strengthens and soon becomes the salient feature. Eventually yet another circulation is superimposed. It is shown how this work connects up with that of other observers, and emphasis is placed on the common occurrence, in many acoustic phenomena, of circulatory motion in association with vibratory motion. A.

534.232 : 621.395.61

6087. Erratum: A second-order gradient noise canceling microphone using a single diaphragm. W. A. BEAVERSON AND A. M. WIGGINS. Letter in *J. Acoust. Soc. Amer.*, **23**, 370 (*May*, 1951).

See Abstr. 157 (1951).

534.321.9

6088. Bibliography. Supersonics or ultrasonics 1926–1949 with supplement to 1950. B. CURRY, E. HSI, J. S. AMBROSE AND F. W. WILCOX. *Research Foundation, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

See Abstr. 6319 (1950). Re-issue, with supplement to 1950.

534.62

6089. Anechoic chamber for acoustic measurements. D. W. ROBINSON. *Elect. Commun.*, **28**, 70–7 (*March*, 1951).

Design and constructional details are given. Methods of testing the quality of acoustic rooms are discussed and details are given of the tests made in this room. The results emphasize the difficulty of setting up a locally uniform sound field and the care necessary in selecting the sound source appropriate to a particular experimental purpose. G. F. HODSMAN

534.844.1

6090. An automatic reverberation measuring apparatus. F. J. VAN LEEUWEN. *Tijdschr. Ned. Radiogenoot.*, **16**, 13–37 (*Jan.*, 1951) *In Dutch.*

An apparatus for measuring the reverberation time of rooms is described. It is based on a new principle, enabling the reverberation time *v.* frequency to be recorded automatically on a paper strip.

OPTICS . RADIATION . SPECTRA 535

535

6091. Early work in applied optics at the National Bureau of Standards. E. C. CRITTENDEN. *J. Opt. Soc. Amer.*, **41**, 369–76 (*June*, 1951).

535.214

6092. Radiation pressure in a refracting medium. R. V. JONES. Letter in *Nature, Lond.*, **167**, 439–40 (*March* 17, 1951).

By using a torsion head capable of detecting angles of 10^{-5} rad. it is found that radiation pressure is directly proportional to the refractive index of the medium. N. CORCORAN

535.23

6093. The complete energy spectrum (scale). A. P. BELYAKOV. *Elektrichestvo, No.* 1, 57–9 (*Jan.*, 1951) *In Russian.*

A well-compiled tabulation in scale-form of every type of energy accumulation, liberated energies by the various known physical processes, etc., in kWh, beginning with the 10^{65} kWh associated with the 100 million galaxies detectable by modern telescopes down to the 10^{-42} associated with a wave of 0·01 c/s. Nuclear processes and their energy yield and energies associated with elementary particles are specially considered, as well as total annual energy values of solar and celestial radiation incident on 1 cm² of the earth's surface at places like Tashkent (approximately equal to the energy irradiated by 1 cm² solar surface in 1 min). B. F. KRAUS

535.24

6094. Heterochromatic photometry using rotating filters and a colour wedge. E. G. WALSH AND H. S. WOLFF. Letter in *Nature, Lond.*, **167**, 683–4 (*April* 28, 1951).

The relative intensities of the Na (590 mμ) and Li (670 mμ) radiations from a flame are determined by passing them alternately through two colour filters mounted in a disk rotated between the flame and a photocell. One filter has a high transmission for 590 mμ and the other for 670 mμ and the required ratio is found by adjusting the alternations of photocurrent to zero amplitude by means of a wedge with a high absorption for 590 mμ. J. W. T. WALSH

535.241.33 : 621.326 : 621.316.7

6095. A method of keeping the luminance of a lamp constant without the use of an electric meter. R. W. G. HUNT. *J. Sci. Instrum.*, **28**, 180–1 (*June*, 1951).

Two electric lamps are connected in parallel to the same source of supply, one directly, and the other through a series resistor. Their luminances are compared in a photometer which is biased in favour of the dimmer lamp. On varying the supply voltage a luminance match is obtained at a unique setting, resulting in a unique luminance. A.

535.315

6096. Application of the Study's co-ordinate of a straight line to geometrical optics. I. T. MATSUYAMA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 489–93 (*Dec.*, 1949).

The position and direction of a straight line are represented by the Study's coefficients and the laws of reflection and refraction are derived. The results are used to calculate the curvature of prismatic spectrum lines, the classical result being obtained. R. W. FISH

535.317

6097. Image formation for objects lying in a principal section of a system. F. STAEBLE. *Optik*, **8** (*No.* 1–2) 1–23 (1951) *In German.*

The passage of a wavefront through an optical system possessing a plane of symmetry is calculated, using as parameters the angles which the projections of the wave normal (or ray) make with the principal ray. This enables the coefficients of the image formation (aberrational coefficients) to be determined. Sagittal and tangential coma, their influence upon the focal lines and their chromatic variation are considered in detail and recurrence formulae given for their computation. R. W. FISH

535.317.6

6098. The Seidel formulae after elimination of the object ray. H. SLEVOGT. *Optik*, **8**, 180–6 (*April*, 1951) *In German.*

Usually the Seidel aberration coefficients are computed in terms of the data of the object- and image-forming ray. Here they are expressed in terms of the principal ray data of the system by a transformation of the formulae. The five Seidel coefficients and the aberration of the pupil are calculated in terms of the Abbe invariant of the principal ray. R. W. FISH

535.317.6

6099. Differential correction of an optical system. A. E. GLANCY. *J. Opt. Soc. Amer.*, **41**, 389–96 (*June*, 1951).

Assuming the usual trigonometrical calculation for an approximate optical system, seven differential equations are set up for spherical aberration, coma, distortion, field errors, power and colour. The equations are so expressed that the same principle is used both for the aperture ray and the field ray. The discussion is complete enough for a computer to use. A Tessar-type photographic lens system is given as an example. A.

535.33

6100. Spectroscopy from the point of view of the communication theory. I. Resolution. G. W. KING AND A. G. ELMSLIE. *J. Opt. Soc. Amer.*, **41**, 405–12 (*June*, 1951).

The following factors which affect resolution, the numerical aperture of the instrument D/f, finite entrance and exit slits ($2d$), absorption of the prism B, and the finite width of the absorption line 2δ, have been treated simultaneously to get the exact relationship between the resolving power $2a$ and slit width. The results are presented graphically for various values of natural line width and the prism absorption. For B, δ and d/δ large, the relationship can be approximated by a law of quadrature $3a^2 = 4d^2 + (\delta + B)^2$, where a, d and δ are measured in units characteristic of the diffraction pattern at wavelength λ, $\lambda f/\pi D$. The absorption coefficient in absolute units is multiplied by a quarter of the base of the prism to give B. In the practical range, the law of combination is much stronger, and the resolving power for small δ and B can actually be better than that expected from the geometrical optics of the slits alone. A.

535.33.03 : 537.523.4

6101. A spectroscopic study of a condensed spark between copper electrodes in illuminating gas, air and carbon dioxide at various pressures. II. J. SINGH. *Indian J. Phys.*, **24**, 321–30 (*Aug.*, 1950).

See Abstr. 1812 (1947) for part I. Spectra of the above gases, at pressures ranging from 1 to 40 cm Hg were recorded with a quartz spectrograph and are reproduced. A capacitance of 0·0018 μF was used. The general appearance of the spectra

is described and the conditions necessary for excitation of the first negative and second positive N bands and the cyanogen violet bands are tabulated.

J. D. CRAGGS

535.33.03 : 536.523.4

6102. A spectroscopic study of an uncondensed spark between copper electrodes in three different gases at various pressures. III. J. SINGH. *Indian J. Phys.*, **24**, 373–7 (*Sept.*, 1950).

Discusses in general terms the various band systems emitted in illuminating gas, air and carbon dioxide with an uncondensed discharge. Spectra are reproduced. J. D. CRAGGS

535.33.07–15

6103. A double-beam recording infra-red spectrometer. K. S. TETLOW, J. MCAUSLAN, K. J. BRIMLEY AND W. C. PRICE. *J. Sci. Instrum.*, **28**, 161–7 (*June*, 1951).

A double-beam recording i.r. spectrometer is described which employs a monochromator and servo system of novel design. The double-beam principle adopted is similar to that of Lehrer and Wright. The monochromator is compact and uses relatively cheap and readily available components. The performance of the instrument is shown by reproductions of typical spectrograms. A.

535.331 : 537.228.5 : 539.153.4

6104. The Stark effect in hydrogen at low field-strengths. G. LÜDERS. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 301–21 (1951) *In German.*

The splittings for levels $n = 1$, 2, 3 and 4 have been calculated for the whole range of field-strengths from zero to the region where the fine-structure effects become unimportant. The results of some intensity calculations for the Stark effect in the lowest Lyman lines and in $H\beta$ are also given. The results are in poor agreement with the experimental findings of Steubing and Junge [Abstr. 4827 (1950)]. R. F. BARROW

535.337 : 535.343.4

6105. Experimental study of the perturbation of the sodium D lines by nitrogen and argon at pressures up to 1 000 kg/cm². S. ROBIN, J. ROBIN AND B. VODAR. *C.R. Acad. Sci., Paris*, **232**, 1754–6 (*May* 7, 1951) *In French.*

The variation of line-width with pressure is described. The measurements also reveal a broad satellite absorption band with maximum at 5 565 ± 10 Å at 1 000 atm. and 400°C. R. F. BARROW

535.337 : 537.525.5

6106. Excitation of nitrogen in a sodium arc. C. K. SUNDARACHAR. Letter in *Nature, Lond.*, **167**, 646 (*April* 21, 1951).

Describes the excitation of the first negative bands of N in a Na/N_2 arc.

535.338

6107. Continuous emission spectra of mercury. G. BALASSE AND M.-L. LEMMENS. *Bull. Acad. Roy. Belge Cl. Sci.*, **37** (*No.* 1) 56–78 (1951) *In French.*

Spectrographs were made of electrodeless discharges in Hg vapour at pressures between 4 and 156 mm and temps. up to 600°C. Plates show these spectra and microphotometer traces. Four main types of continuous spectrum were distinguished. The first two are of molecular origin involving different excitation levels. The third is considered to be due to the coexistence of two modes of recombination of an electron, namely with the ionized atom or the molecule of Hg; this continuum includes structures interpreted as resulting from transitions between the states $6\,^1S_0 + 7$, 8 or $9\,^1D_2$ and the state $6\,^1S_0 + 6\,^1P_1$. The fourth type of spectrum is due to the recombination of an electron with a singly ionized atom. S. T. HENDERSON

535.338 : 536.46 : 541.124 : 535.379

6108. Flame spectra of systems containing oxygen as NO_2. H. BEHRENS AND F. RÖSSLER. *Z. Naturforsch.*, **6a**, 154–60 (*March*, 1951) *In German.*

The flame spectra of systems such as benzene-nitric oxide, benzene-tetranitromethane, differ from those of hydrocarbon-oxygen systems in the absence of C_2 bands and in the presence of the 3 240 Å system of NH and of the Fourth Positive system of CO. It is supposed that excited $NH(A^3\Pi)$ and $CO(A^1\Pi)$ are formed in the reactions: $C_2 + NO = CO + CN$, $CH + NO = CO + NH$. R. F. BARROW

535.338.333 : 539.155.2

6109. Isotope shifts in some lines of carbon and nitrogen. J. R. HOLMES. Letter in *J. Opt. Soc. Amer.*, **41**, 360–1 (*May*, 1951).

Interferometric studies of the line of CI at 2 478 Å show that the heavier isotopes exhibit shifts to longer wavelength. The values are $-0{\cdot}156\times0{\cdot}002$ and $-0{\cdot}294\times0{\cdot}002\ cm^{-1}$ for C^{13}–C^{12} and C^{14}–C^{12} respectively. They appear to be determined entirely by mass effects. Measured shifts for N^{15}–N^{14}, averaging $-0{\cdot}05\ cm^{-1}$, supplement those already published [Abstr. 1055 (1943)]. R. F. BARROW

535.338.4

6110. New spectra in the glow discharge in benzene vapour. H. SCHÜLER AND L. REINEBECK. *Z. Naturforsch.*, **6a**, 160–5 (*March*, 1951) *In German.*

Low-current positive-column discharges through benzene-helium mixtures have been investigated. The character of the spectrum changes markedly with conditions of excitation, which were varied by altering the partial pressure of benzene vapour. Four new spectra, of which reproductions are given, were obtained: the emitters are not known. R. F. BARROW

535.338.4

6111. Calculated transition probabilities for the C_2 Swan bands. A. MCKELLAR AND N. R. TAWDE. Note in *Astrophys. J.*, **113**, 440 (*March*, 1951).

Discrepancies between computed transition probabilities by Tawde and Patel and by McKellar and Buscombe [see Abstr. 8612 (1950)] are mainly due to computing errors by both parties. D. L. EDWARDS

535.338.4

6112. The band-spectrum of carbon monofluoride, CF. E. B. ANDREWS AND R. F. BARROW. *Proc. Phys. Soc., Lond. A*, **64**, 481–92 (*May*, 1951).

Measurements of two band-systems attributed to CF are reported. A rotational analysis of four

bands, 1,0, 0,0, 0,1 and 1,1, of a transition $A^2\Sigma^+ - X^2\Pi$ is given, and the vibrational analysis of a system B (near case b) $- X^2\Pi$. The rotational constants of the B state have been estimated from band-head separations. $X^2\Pi$ is probably the ground-state of CF. The initial convergence of the vibrational levels in B is rather rapid, and suggests that D_2'' is about $4{\cdot}9_6$ eV. A.

535.338.4

6113. Fractional transition probabilities of the first positive band system ($B^3\Pi \rightarrow A^3\Sigma$) of molecular nitrogen. C. E. MONTGOMERY AND R. W. NICHOLLS. Letter in *Phys. Rev.*, **82**, 565 (*May* 15, 1951).

Numerical values for vibrational transition probabilities are calculated to $v' = 8$ and $v'' = 16$.

A. G. GAYDON

535.338.4

6114. Emission of the forbidden oxygen lines by molecular dissociation. R. HERMAN, C. WENIGER AND L. HERMAN. Letter in *Phys. Rev.*, **82**, 751 (*June* 1, 1951).

The red lines are due to excitation to the $B^3\Sigma_u^-$ state of O_2 above the dissociation limit. In mixtures of O_2 with argon or xenon, quasi-continuous band systems are observed near the green auroral line; a vibrational analysis for AO is given. A. G. GAYDON

535.338.4–31

6115. A new ultraviolet band system of the C_2 molecule. H. FREYMARK. *Ann Phys., Lpz.*, **8** (*No.* 5–8) 221–39 (1951) *In German.*

The rotational analysis of 9 bands of a new system, $e^1\Sigma_g^+ - b^1\Pi_u$ with $\nu_e = 46\,643{\cdot}6$ cm^{-1} is reported. The lower state is the lower state of the Deslandres–d'Azambuja bands. The constants of the state $e^1\Sigma_g^+$ are as follows: $B = 1{\cdot}790 - 0{\cdot}0421u$; $G = 1\,671{\cdot}5u - 40{\cdot}02u^2 + 0{\cdot}248u^3$, where $u = v + \frac{1}{2}$. Perturbations are observed in the state *e*.

R. F. BARROW

535.341–15

6116. Reflection and transmission infrared cells for use at liquid air temperatures. L. F. H. BOVEY. *J. Opt. Soc. Amer.*, **41**, 381–4 (*June*, 1951).

After a short discussion on the theoretical and practical aspect of the use of low temperatures in infrared spectroscopy, details are given of two simply constructed cells in which samples may be cooled with liquid air as the refrigerant. One of these, in which a stainless steel mirror carrying the sample is cooled, provides a means whereby the temperature can be controlled. It is also pointed out that loss of energy from reflection effects at the surface of the solid layer may occur in both the reflection and transmission types of cell. A.

535.341–31

6117. On a simple arrangement for the quantitative determination of the course of absorption in the ultraviolet region. V. KEUSSLER, V. *Z. angew. Phys.*, **3** (*No.* 3–4) 110–13 (1951) *In German.*

Special features of the rapid and accurate photographic method described are the production of a continuous, line-free, background spectrum by means of a water-submerged, high-frequency spark-discharge between Al wires (dia. 2 mm), using a Tesla transformer; and the compensation of intermittent variations in the intensity of the light source by mounting the pair of quartz absorption vessels on an oscillating table so that the sample and comparison solution comes in turn between the light source and the microphotometer. A system of screens and a wedge-shaped slit are used to smooth out the transmitted radiations during the moment of transmission from one vessel to the other. J. GRANT

535.342

6118. Transmittance measurement of samples of small area with the Hardy recording spectrophotometer. F. J. BAUM. Letter in *J. Opt. Soc. Amer.*, **41**, 427 (*June*, 1951).

535.343

6119. Excited triplet states of some polyatomic molecules. I. D. S. MCCLURE. *J. Chem. Phys.*, **19**, 670–5 (*June*, 1951).

Molecules in their metastable triplet state are obtained by intense ultraviolet excitation, and the absorption spectrum of the excited molecules is then measured. The conditions needed to obtain the required concentration of excited molecules are shown, and a method for determining this concentration is developed. This enables one to determine the extinction coefficient for the triplet-triplet transition and is an aid in characterizing the new state. The methods are applied to a number of compounds having long-lived triplet states. A.

535.343 : 541.57

6120. The intensity of the valence-vibration line of the C=C bond in combination scattering spectra of hydrocarbons. P. A. AKISHIN AND V. M. TATEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 4) 527–30 (1951) *In Russian.*

Characteristic frequencies exist representing different C=C bond arrangements in open chain or cyclic hydrocarbons. The isolated C=C bond has an intensity per mole independent of the surroundings in the molecule. For several isolated C=C bonds: (i) the intensity is increased, if the bonds are of same type, (ii) separate characteristic lines appear, if of different type. The differentiated and integrated intensities allow the half-width to be calculated, hence these results may be useful in quantitative structural analysis. J. JACOBS

535.343–15 : 535.375.5

6121. Infra-red and Raman spectra—recent advances in Great Britain. A. C. MENZIES. *Trans Instrum. Meas. Conf., Stockholm* (1949) 29–36 (1950).

New apparatus and accessories for observation of infra-red and Raman spectra are reviewed.

W. R. ANGUS

535.343.2

6122. The line spectrum of the rare-earth crystalline salts. I. The splitting of the electronic terms of rare earths ions in a crystal field (static one-atom model), particularly in $R(BrO_3)_3{\cdot}9H_2O$. H. GIESEKUS. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 350–72 (1951) *In German.*

The effect of the crystal field on the 4*f*-electrons is treated as a perturbation. A general theorem is given for the splitting of the terms of two complementary

configurations, and the splitting of the more important terms is worked out in detail for all rare earths in a particular crystal. L. PINCHERLE

535.343.2

6123. The line spectrum of the rare-earth crystalline salts. II. The effect of lattice vibrations on the spectrum lines of rare earths ions in a crystal field (dynamic one-atom model). H. GIESEKUS. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 373–90 (1951) *In German.*

The effect on the 4*f*-electrons is treated both classically (according to Born's theory) and by standard quantum-mechanical methods. The shape of the spectrum lines depends on the structure of the crystal and on the temperature and approaches a Gaussian form in the classical limit. Comparison with experiment (particularly in the case of Nd double nitrate) shows that the width of the lines is not determined mainly by the interaction with the lattice vibrations, but arises through the different forms of potential wells in the initial and final states. L. PINCHERLE

535.343.2–15

6124. The infrared spectrum of KHF_2. J. A. KETELAAR AND W. VEDDER. Letter in *J. Chem. Phys.*, **19**, 654 (*May*, 1951).

The reflection spectrum from a crystal, using polarized radiation, confirms that bands at 1 238 and 1 490 cm^{-1} are due to a doubling of the asymmetric valency vibration. G. F. LOTHIAN

535.343.4 : 533.7 : 541.12

6125. Quantitative studies of the absorption in the visible bands of bromine and iodine vapours. G. KORTÜM AND W. LUCK. *Naturwissenschaften*, **38**, 100 (*Feb.*, 1951) *In German.*

The absorption has been studied over wide ranges of pressure and path-lengths. I_2 shows deviations from Lambert's law. The mean oscillator-strengths, *f*, at 5 461 Å are: Br_2 $5{\cdot}2\times10^{-8}$, I_2 $7{\cdot}45\times10^{-7}$. The effective optical diameters for I_2–I_2 collisions are about 1·37 times larger than for I_2–N_2. The absolute values of the optical diameters are about 1·3 to 1·8 times bigger than the kinetic theory diameters. R. F. BARROW

535.343.4–14 : 539.133

6126. The microwave spectra, structure, and dipole moments of ethylene oxide and ethylene sulfide. G. L. CUNNINGHAM, JR, A. W. BOYD, R. J. MYERS, W. D. GWINN AND W. I. LE VAN. *J. Chem. Phys.*, **19**, 676–85 (*June*, 1951).

The microwave spectra of $C_2{}^{12}H_4O$, $C^{12}C^{13}H_4O$, $C_2{}^{12}D_4O$, $C_2{}^{12}H_4S^{32}$, $C_2{}^{12}H_4S^{34}$ and $C_2{}^{12}D_4S^{32}$ have been determined. For each isotopic species three moments of inertia are obtained. From the 9 moments of inertia for each compound, a set of "effective" bond distances and angles (5 in number) have been selected. These "effective" bond distances are all self-consistent to 0·002 Å or better. A brief discussion of the resulting structure is given. The dipole moments of C_2H_4O and C_2H_4S were determined from the magnitude of the Stark splitting. A.

535.343.4–15

6127. Combination bands of ethylene [4 206–6 150 cm^{-1}]. E. K. PLYLER. Letter in *J. Chem. Phys.*, **19**, 658 (*May*, 1951).

Grating measurements are reported and assignments of the combinations involved listed. A new value for one fundamental is found necessary. G. F. LOTHIAN

535.343.4–15

6128. The infrared spectrum of $H_2C{=}CD_2$. J. E. LANCASTER, R. G. INSKEEP AND B. L. CRAWFORD, JR. Letter in *J. Chem. Phys.*, **19**, 661 (*May*, 1951).

Bands observed between 700 and 4 464 cm^{-1} are listed, together with tentative assignments. G. F. LOTHIAN

535.343.4–31

6129. Extension of line series in the arc spectrum of indium: ultra-violet absorption bands probably due to InH and GaH. W. R. S. GARTON. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 509 (*May*, 1951).

535.343.4–31

6130. Sodium bands in the ultra-violet, λλ3100–2750. G. S. CHANG. *Chin. J. Phys.*, **7**, 377–82 (*Sept.*, 1950).

Analyses by Sinha are criticized. Measurements of absorption bands λλ3100–2750 lead to vibrational analyses into two systems represented by $\nu = 33\,486{\cdot}8 + 111{\cdot}3\,u' - 0{\cdot}48\,u'^2 - 159{\cdot}5\,u'' + 0{\cdot}72\,u''^2$ and $\nu = 35\,557{\cdot}0 + 106{\cdot}2\,u' - 0{\cdot}65\,u'^2 - 159{\cdot}5\,u'' + 0{\cdot}72\,u''^2$, where $u = v + \frac{1}{2}$. Both systems involve the ground state. For the second there is a perturbation at $v' = 3$. A. G. GAYDON

537.347

6131. Molecular orientation and light absorption. B. THORELL AND F. RUCH. Letter in *Nature, Lond.*, **167**, 815 (*May* 19, 1951).

Measurement of the light absorption of an anisotropic system by unpolarized light, introduces a systematic error depending on the ratio of the transmission of the two perpendicular components of the incident light. The magnitude of this error is given, with experimental details, for desoxyribose nucleic acid made according to Hammarsten, and examined for 2 types of experiment, viz. within 2% by streaming the mols, and ~ 6% by stretching the acid into microscopic fibres or strips. Contrary, therefore, to previous assumptions, the effect of molecular orientation on the cellular nucleic acid absorption of unpolarized light does not introduce any serious error. Dichroism is high in freshly made fibres. 7 references. H. H. HODGSON

535.347 : 539.133

6132. Peculiarity of dichroism of aromatic molecular compounds. R. TSUCHIDA, M. KOBAYASHI AND K. NAKAMOTO. Letter in *Nature, Lond.*, **167**, 726 (*May* 5, 1951).

For light vibrating ∥ to the C_6H_6 ring the π-bands are more hypsochromic and hypochromic than for ⊥ vibrations. J. JACOBS

535.361.2

6133. The absolute spectral diffuse reflectance of magnesium oxide. W. E. K. MIDDLETON AND C. L. SANDERS. *J. Opt. Soc. Amer.*, **41**, 419–24 (*June*, 1951).

The published values indicate that it should reflect more highly in the red than in the blue. Using a modification of the method described by Preston,

the absolute value of this quantity has been measured between $\lambda = 0{\cdot}24\ \mu$ and $\lambda = 0{\cdot}85\ \mu$. A very carefully prepared surface of MgO on silver has a reflectance of about 0·98 at $\lambda = 0{\cdot}54\ \mu$, where there is a very flat maximum. The reflectance of a fresh surface falls to less than 0·96 at $0{\cdot}4\ \mu$, but exposure to strong ultraviolet light bleaches it, the final result being a reflectance increasing continuously from the near infrared to about $0{\cdot}4\ \mu$, where it begins to fall sharply, reaching 0·96 at about $0{\cdot}25\ \mu$. A sphere lined with such a bleached surface raises the colour-temperature of Planckian radiation a little, and the observed colour agrees well with that predicted from the new results. It is believed that these results are reliable to $\pm 0{\cdot}002$ from $\lambda = 0{\cdot}4\ \mu$ to $\lambda = 0{\cdot}7\ \mu$, but different surfaces prepared with equal care may differ in reflectance by at least 0·005. The bleaching is presumed to be caused by the decomposition of small amounts of magnesium nitride. A.

535.37 : 537.542

Data on fluorescent liquids for scintillation counters. *See Abstr.* 6280

535.37 : 548.0

6134. Studies on the *K* absorption band in the colored rock salt crystal. Y. UCHIDA, M. UETA AND Y. NAKAI. *J. Phys. Soc. Japan*, **6**, 107–13 (*March–April*, 1951).

This band is reported to lie between 250–330 mμ with a max. at 295 mμ. When irradiated with light of the absorption wavelengths the crystal exhibits luminescence accompanied by photo-conduction, during which process *K*-centres decay and transform into *F*-centres. A discussion is given of the nature of the *K*-centres. J. A. FRANKS

535.371

6135. Radiance amplification by multi-stage fluorescence system. W. A. SHURCLIFF. Letter in *J. Opt. Soc. Amer.*, **41**, 209 (*March*, 1951).

The possibility of providing higher brightness at the detector than at the source in such systems as scintillation counters is considered. A series of matched fluorescent solutions or solids, placed between source and detector and each excited by the previous one, is estimated to give 10–100× gain in radiance.

G. F. J. GARLICK

535.371 : 537.312.5 : 548.0

6136. The ionization mechanism and the temperature dependence of photoconductivity and luminescence of crystals. E. I. ADIROVICH. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 5) 665–8 (1951) *In Russian.*

The mathematical treatment of equations describing the relationships in ionization processes of various types (single-stage, double-stage, stationary, kinetic) shows that the comparison of the energy of activation values obtained from the temperature dependence of stationary photoconductivity and from the temperature dependence of the decay of luminescence yields the experimental criterion for the elucidation of the mechanism of electronic processes in crystallophosphors. F. LACHMAN

535.375.5

6137. Line width in the Raman rotatory molecular spectra and "width" of Rayleigh line. M. V. LOYA. *Latv. PSR Zin. Akad. Vēst.*, *No.* 5, 115–19 (1950) *In Latvian.*

In a solid body consisting of *N* molecules, the bond force between them is $\propto$ their relative displacement from equilibrium positions. All the molecules will participate in the thermal movement, but their relative amplitudes and phase differences in the various eigen-oscillations will be different and also the eigen-oscillations distuned between themselves, but by small differences, the smaller, the less interaction exists between them. Hence the finite width of the Raman lines. In addition to the ordinary Raman spectrum there is another in which the frequency variation of the incident light is very small. This frequency variation of the exciting light causes Rayleigh-structure of the line and is due to very slow thermal vibrations of the lattice. A formula for this Rayleigh line width is given. B. F. KRAUS

535.375.54 : 548.7

6138. Applications of spectral analysis to the study of crystals. J. CABANNES. *Ann. Acad. Sci. Fennicae, Ser. A* **1**, *No.* 82, 29 *pp.* (1950) *In French.*

A review of the work done at the Sorbonne, the Ecole Normale Superieure and the University of Bordeaux, on Raman spectra. C. TURNER

535.376

6139. Extinguishing action of long wavelength radiation in electrophotoluminescence. II. Interpretation of results. F. VIGEAN AND D. CURIE. *C.R. Acad. Sci., Paris*, **232**, 955–7 (*March* 5, 1951) *In French.* See Abstr. 4300 (1951) for part I.

535.376

6140. Deterioration of anthracene under α-particle irradiation. J. B. BIRKS AND F. A. BLACK. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 511–12 (*May*, 1951).

535.39 : 538.566.2

6141. Two theorems relating to the propagation of waves in stratified media. F. ABELÈS. *C.R. Acad. Sci., Paris*, **232**, 1415–17 (*April* 9, 1951) *In French.*

A stratified medium is considered in which the dielectric constant ε and permeability μ have the values ε_0, μ_0 for $z < 0$, ε_1, μ_1 for $z > d$, $\varepsilon(z)$, $\mu(z)$ for $0 < z < d$, where $\varepsilon_0 \leqslant \varepsilon(z) \leqslant \varepsilon$ and $\mu_0 \leqslant \mu(z) \leqslant \mu_1$. Theorem 1 is that the reflecting power R of the middle layer when $d \neq 0$ is less than the value of R for the common boundary when $d = 0$. Theorem 2 relates to the phase changes suffered by the wave on reflection and refraction, for different angles of incidence. The theorems show that the information about μ and ε for the middle layer which can be obtained from optical measurements is restricted.

A. T. PRICE

535.391.2

6142. Gloss measurement of papers—the effect of luminance factor. V. G. W. HARRISON AND S. R. C. POULTER. *Brit. J. Appl. Phys.*, **2**, 92–7 (*April*, 1951).

535.417

6143. The correction for dispersion of phase change in Fabry–Perot interferometers. H. BARRELL AND P. TEASDALE-BUCKELL. *Proc. Phys. Soc., Lond. B*, **64**, 413–18 (*May*, 1951).

A technique based on well-known interferometric procedures is described for determining the corrections

for phase-change dispersion at reflection in Fabry–Perot interferometers. Results obtained during precise determinations of mercury-198 wavelengths are quoted to illustrate its application. A marked difference is found between the dispersion corrections for the silvered and aluminized mirrors actually used, and it is established that the latter have negligible corrections in the region 4 047 to 6 438 Å. A.

535.417

6144. Measurement of the thickness of thin films by multiple-beam interferometry. O. S. HEAVENS. *Proc. Phys. Soc., Lond. B*, **64**, 419–25 (*May*, 1951).

The method of measuring the thickness of thin films by multiple-beam Fizeau fringes has been studied in order to assess the accuracy attainable. The small-scale irregularities on the surfaces of optical flats and other optically worked glass have been studied by multiple-beam methods. The effect of these irregularities on the accuracy of the thickness measurements is shown and the conditions for optimum accuracy are discussed. Thickness measurements have been made on films of Ag and of LiF with several different metals as reflecting layers. The measurements cover the range 120 to 1 500 Å. The results for the different reflecting layers show agreement to within the observational error provided that measurements are made within a short time of the preparation of the films. With Ag as the reflecting layer an accuracy of $\pm$ 10 Å can be expected if suitable precautions are taken. A.

535.417

6145. Effect of size and spectral purity of source on fringe pattern of the Mach-Zehnder interferometer. F. D. BENNETT. *J. Appl. Phys.*, **22**, 776–9 (*June*, 1951).

In analysis of Mach–Zehnder interferograms taken of the axi-symmetric flows about supersonic projectiles, the question arises whether errors in fringe width occur because of the finite size and non-zero spectral width of the source employed. Under the assumptions that the source is a circular area normal to the axis of the interferometer with spectral intensity function approximated by a Gaussian error curve, it is shown that the deviations from ideal fringe width λ_0/ε caused by source size and spectral line width are negligibly small for an interferogram with 200 fringes on either side of centre. The limiting factor is not deviation in fringe width but the exponential damping of fringe intensity amplitude owing to the spectral bandwidth of the source. This reduces the fringe contrast below experimental detectability long before deviations in fringe width become appreciable. A.

535.417 : 534.152

Vibration measurement by interferometry. *See Abstr.* 6080

535.417 : 539.23

6146. Some applications of interferometry to the examination of an electrodeposited film. S. TOLANSKY. *J. Electrodepos. Tech. Soc.*, **27**, *Paper* 6, 8 *pp.* (1951).

Multiple-beam interference methods are applied to the examination of bright tin-nickel electrodeposit on polished brass. It is shown by precision interferometry that the electrodeposit contours surface irregularities as small as 1 micro-inch, although the deposit is as thick as 220 micro-inches. The thickness of the deposit can be measured by the fringes to within 1 micro-inch by visual inspection alone. Some hardness micro-indentation tests are reported using a Vickers pyramid. Although the pyramid penetrates the deposited film yet an apparent increase in surface hardness is found. S. TOLANSKY

535.42

6147. On the mathematical treatment of the effect of the width of the slit on Fraunhofer's diffraction phenomenon. H. TAKEYAMA, T. KITAHARA AND T. MATUBAYASI. *J. Sci. Hiroshima Univ., Ser. A*, **14**, 239–42 (*Sept.*, 1950).

In the Fraunhofer diffraction pattern due to N slits, $(N-2)$ subsidiary maxima are found between 2 principal maxima when the collimator slit is narrow. As it is broadened, the subsidiary maxima disappear one by one. The effect is treated by assuming the collimator slit to give light from a number of discrete directions, the number depending upon its breadth. Qualitative agreement with experimental results is obtained. R. W. FISH

535.42 : 534.22

6148. Diffraction of light by supersonic waves. R. MERTENS. *Meded. K. Vlaamse Acad. Wetensch., Belg.*, **12** (*No.* 7) 37 *pp.* (1950).

The problem is formulated and a summary of earlier treatments is given. The difference differential equations of one of these (due to Raman and Nath) are discussed. It is concluded that the Raman–Nath theory is valid if either, or both, the intensity and wavelength of the ultrasonic waves are very large. This corresponds with writing a parameter $\rho = 0$. A solution for $\rho \ll 1$ is then obtained by calculating correction terms for the solution when $\rho = 0$. The intensities of the various spectra are expressed in terms of integral order Bessel functions together with polynomials which are defined in the text.

H. H. HOPKINS

535.421

6149. On the production of diffraction gratings. I. The copying of plane gratings. G. D. DEW AND L. A. SAYCE. *Proc. Roy. Soc. A*, **207**, 278–84 (*June* 22, 1951).

The paper is the first of a series describing the development at the National Physical Laboratory of new methods of making, copying and testing diffraction gratings. It describes the development of a method devised by Merton (1950) for copying a plane grating by using a plastic pellicle to transfer the cast of the grating to a gelatine surface. It shows how to obtain such pellicles free from distortion and how to make optically flat gelatine surfaces. The diffracted wave-fronts of parent and replica respectively agree to a fraction of a fringe. A.

535.43

6150. Distribution of brightness in strongly dispersing media. V. A. TIMOFEEVA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 5) 677–80 (1951) *In Russian.*

By means of two plane mirrors, sunlight was beamed into a reservoir containing a strongly dispersing medium such as milk, for which the absorption coeff. is negligible in comparison with the scattering coeff. The reservoir was shielded from any other

extraneous light. A specially constructed photometer provided with a Se photoelement was used for investigating the brightness at different depths and in different directions, the light in a solid angle of 0·39° could be determined. It was found that the brightness of the light in the principal direction of the incident beam ($\phi = 0$) could be expressed by $I = I_0 e^{-kl}$ where I is the brightness at a depth l, I_0 at the surface and k the scattering coeff. This equation holds to a depth of 6–8 rayleighs (1 rayleigh is the depth in passing through which the light weakens e times). At greater depths the rate of decrease in brightness slows down until there is maximum scattering, further decrease in the brightness in the $\phi = 0$ direction can be expressed by $I' = I'_0 e^{-k'(l-l_0)}$ where I'_0 is the brightness at l_0 for the beginning of total scattering, I' the brightness at depth l, and k' the coeff. of decrease for totally scattered light. Due to the decrease in the brightness in direction $\phi = 0$ there is a corresponding increase in brightness in other directions. The depth of max. scattering was found to vary with ϕ, thus for $0 < \phi < 120°$, the depth first increases to a max. and then decreases. k and k' were found to be related by the equation $k' = \sqrt{(Ak)}$ where the parameter A increases with decreasing size of the scattering particles and also varies with the absorption coeff. of the medium. W. HUGHES

535.43

6151. The question of the distribution of brightness in the sea. V. A. TIMOFEEVA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 6) 831–3 (1951) *In Russian.*

Using a mirror photometer, the fundamental part of which was a hermetically sealed Se photoelement placed at the principal focus of a glass concave mirror, measurements of the distribution of brightness in the sea were made on bright days, to a depth of 70 m. The angle of vision of the photometer could be varied from 0·8° to 6·6°. Tests were made for $\phi = 0$–120° in both directions from the principal axis (ϕ is the angle between the principal optical axis of the photometer and the direction of the sun's refracted rays in the sea). Results were obtained which confirmed those obtained in the laboratory (preceding Abstr.).

W. HUGHES

535.43 : 548.4

6152. Coherent scattering of light by monocrystals and intrinsic block structure. R. FÜRTH AND S. P. F. HUMPHREYS-OWEN. *Nature, Lond.*, **167**, 715–17 (*May* 5, 1951).

The scattering is measured with an electron-multiplier photocell and monochromatic light between 6 000 Å and 2 400 Å at right-angles to the incident beam, on two rocksalt crystals. The dependence of scattering intensity on λ is the same for both, although one scatters 20× as much as the other. Vibrational ratios 1, $\sqrt{2}$, $\sqrt{3}$, 2, . . . , calculated for cubic blocks, agree with the experimental scattering maxima.

C. TURNER

535.551 : 548.0

6153. Photoelastic constants of sodium chlorate. G. N. RAMACHANDRAN AND V. CHANDRASEKHARAN. Letter in *Nature, Lond.*, **167**, 567 (*April* 7, 1951).

Preliminary communication. The piezo-optic constants are given as $q_{11} - q_{12} = -2{\cdot}39 \times 10^{-13}$; $q_{11} - q_{13} = -1{\cdot}42 \times 10^{-13}$; $q_{44} = -1{\cdot}58 \times 10^{-13}$; $q_{11} = +1{\cdot}48 \times 10^{-13}$ cm^2 dyne^{-1}, and the elasto-optic constants found to be $p_{11} = 0{\cdot}173$, $p_{12} = 0{\cdot}258$, $p_{13} = 0{\cdot}223$, $p_{44} = -0{\cdot}0187$. Within limits of experimental error there was no change in the rotatory power with stress in directions transverse to the stress.

H. G. JERRARD

535.56 : 539.133

6154. Optically active crystals. M. V. VOLKENSHTEĬN AND E. K. BYUTNER. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 4) 515–17 (1951) *In Russian.*

Difficulties in the theory of the optical activity of anisotropic media are discussed. An equation for the energy density is derived rigorously including electric dipole and quadripole and magnetic dipole terms, and it is found to be the same as that given by Born [*Optik* (1937)], who considered only electric dipole terms. Without the extra terms conservation of energy is not satisfied. A solution for plane waves is given. See also Abstr. 5754, 7178, 7926 (1950).

A. L. MACKAY

535.565

6155. Rotatory power and other optical properties of certain liquid crystals. H. DE VRIES. *Acta Cryst.*, **4**, 219–26 (*May*, 1951).

A group of liquid crystals, mainly derivates of cholesterol, shows remarkable optical properties, including strong rotatory power and selective reflection of circularly polarized light in a narrow region of wavelengths. In this paper it is shown how these properties can be explained by the assumption that the molecules are arranged in a special way, so that the electrical axes rotate screw-like. It is inessential whether this occurs in small steps or continuously. When the axes make one revolution over a thickness p, then light in a region around $\lambda = pn$ will be reflected (n = refractive index). The second important parameter is the value of the double refraction $\alpha = (n_2 - n_1)/n$. From p and α all optical properties can be calculated. No accurate data for testing the theory are available but qualitatively the agreement is complete.

A.

535.64

6156. Color change from daylight to night light, calculated and observed. I. H. GODLOVE. *J. Opt. Soc. Amer.*, **41**, 396–401 (*June*, 1951).

From the "pure physics" of illumination, a sky blue in daylight should change to a honey yellow in 60 W tungsten light. For most colours, the data of Helson and Grove, plotted on a circular Munsell diagram, show that adaptation permits only about half the change calculated and plotted from the "pure physics." Conversion from I.C.I. Illuminants C to A was accomplished with a special filter and the tristimulus integrator. Other colours show lines of change approximately parallel to that for sky blue (except yellows and oranges, which become redder). Such lines indicate large hue changes for some starting hues and large chroma changes for others. Assuming all changes as half those of "pure physics" yields "theoretical" curves for change of hue and chroma plotted against starting hue. Two points each of zero change and large plus or minus change were found for both hue and chroma; large hue changes occur where chroma changes are small, and conversely. Two-check-direct observations of colour changes in

lights close to C and A on each of about 150 dyeings, using 8-step scales, confirmed the maxima and minima and general "theoretical" curve shapes very well. To a first approximation, the changes depend only on starting (daylight) colour, slightly on other factors. A section on the behaviour of mixtures is included. A.

535.681 : 628.9

6157. Colour and lighting. G. T. WINCH AND B. M. YOUNG. *G.E.C. J.*, **18**, 88–100 (*April*, 1951).

Continues a previous paper [Abstr. 2388 (1950)] and is principally concerned with colour-rendering by different illuminants, particularly fluorescent lamps. The binocular viewing apparatus used for the experimental work is described. This consists of two large cubes, side by side, so that the observer can view one with the left eye and one with the right. Various coloured fabrics were viewed in this apparatus with two different illuminants in the two cubicles; additional light of adjustable colour was directed on to one sample of a pair until it seemed to match the other sample in the other cubicle under a different illuminant. A large number of results is presented and analysed. J. W. T. WALSH (R)

535.8 : 531.715.2

6158. Some points in the design of optical levers and amplifiers. R. V. JONES. *Proc. Phys. Soc., Lond. B*, **64**, 469–82 (*June*, 1951).

The design of optical levers with photoelectric amplifiers is examined and sources of instability are traced. Convection currents causing refraction variations are found in some circumstances to affect the light balance in the optical lever; they may be minimized by properly designed shrouds around the optical path. The better known causes of instability are discussed, and the appropriate remedies are described. The discussion is extended to the stability of galvanometers. The design of an optical lever and amplifier is given which can detect a change of 10^{-9} radian in a mirror 5 mm in diameter with an indication time of 1 sec and with a long-term drift of the order of 10^{-8} radian/hour. A.

535.822.9

6159. An interference microscope for use with transmitted or reflected light. W. KRUG AND E. LAU. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 329–40 (1951) *In German.*

This system requires a single microscope objective and not the usual matched pair. Light is divided at a half-silvered surface between the microscope objective and the specimen, fringes being formed by interference of the beams reflected by the specimen and a standard comparison surface. For examination of specimens by transmitted light, two beam-splitting prisms are used, and fringes are formed by interference of beams passing through the specimen and a standard comparison plate. Practical details of both instruments are given and their use in physics, engineering and biology briefly discussed. R. W. FISH

535.822.9

6160. 'Phase-contrast' methods and birefringence. R. BARER. Letter in *Nature, Lond.*, **167**, 642–3 (*April* 21, 1951).

Phase contrast microscopy, interference microscopy, Schlieren and dark ground illumination may require the use of polarized light when birefringent objects are examined. Practical details and experimental results obtained with crystals, fibres and other biological material are briefly described. R. W. FISH

535.89 : 535.375.5

6161. The optimum illumination of a spectrograph by a homogeneous light-emitting volume, and the minimum volume required. W. BECKER. *Optik*, **8**, 173–9 (*April*, 1951) *In German.*

Following Nielsen's earlier theoretical work on the problem, it is shown that the brightness of the spectral lines in the Raman effect may be doubled by a plane mirror at the end of the liquid container. The volume of liquid required may be decreased by a suitable optical system between the tube and the spectrograph slit. S. T. HENDERSON

535.89 : 621.327.44

6162. Xenon compact arc lamps. W. T. ANDERSON, JR. *J. Opt. Soc. Amer.*, **41**, 385–8 (*June*, 1951).

A.c. Xe compact arc lamps with Xe gas pressures between 20 and 60 atm. have been made and their behaviour has been compared with similarly constructed Hg-filled lamps. Unlike the Hg lamp, which is electrode-stabilized and may be operated in any position, the Xe lamp is convection-controlled and operable only in a nearly vertical position. The lumen efficiency per watt per cm of arc is about the same for Hg and Xe; but, because of higher voltage gradients in the former, the over-all efficiency of light production is higher for Hg than for Xe. Radiation characteristics for the Xe lamps were measured. The compactness of the radiating area, about 4·5 mm² for a 150 W lamp, and 12 mm² for a 700 W lamp, gives the lamp high brightness and makes it an optically useful device. A.

HEAT 536

536.2

6163. Erratum: A theory of the envelope type of thermal conductivity tests. A. L. LOEB. Letter in *J. Appl. Phys.*, **22**, 849 (*June*, 1951).

See Abstr. 3478 (1951).

536.2 : 523.877

6164. Thermal conductivity of dense matter. K. S. SINGWI AND M. K. SUNDARESAN. *Proc. Phys. Soc., Lond. A*, **64**, 441–6 (*May*, 1951).

The thermal conductivity of degenerate matter is calculated taking account of the effect of relativistic mechanics. The result is put in a form suitable for astrophysical calculations. The two limiting cases of non-relativistic degeneracy and extreme relativistic degeneracy are discussed. A.

536.24 : 536.5

6165. On the distribution of temperature in the neighbourhood of [a] heated cylinder. S. NAWATA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 445–9 (*Dec.*, 1949).

A Cu tube, 50 mm long and of 5 mm int. and 7 mm ext. dia., heated electrically, was placed in one arm of a Michelson interferometer and the interference fringes surrounding the tube with the tube at room and at various higher temperatures were photographed. From the displacement of the fringes the

isothermals and the temperature gradient in the neighbourhood of the tube were calculated, and the gradient found to be symmetrical about the tube axis at all observed temperatures (up to 23·5°C). With one half of the curved surface of the tube coated with soot the gradient on the coated side was found to be greater than that at the corresponding place on the uncoated side. A hydrodynamical explanation of the observed phenomena is given. S. WEINTROUB

536.41 : 538.22

Ferromagnetic anomaly in the thermal expansion of ferrites. *See Abstr.* 6328

536.413

6166. Supersensitive thermoelements. H. A. POHL. Note in *Rev. Sci. Instrum.*, **22**, 345 (*May*, 1951).

Thermo-mechanical effects in bi-films of polymer materials (e.g. nylon or polythene) with selected orientation but identical chemical composition are ten times greater than similar effects in bi-metallic elements. C. A. HOGARTH

536.42

6167. Loss of mass by evaporation in liquids containing hypothetical [figuré] bodies. A. LÉAUTÉ. *C.R. Acad. Sci., Paris*, **232**, 1411–13 (*April* 9, 1951). *In French.*

In a previous paper [*C.R. Acad. Sci., Paris*, **232**, 600 (*Feb.* 12, 1951)] the author showed that the presence of hypothetical bodies in certain liquids creates a pseudo-structure which during evaporation allows the density of the interpenetrating liquid to become less and less as the upper surface is approached and as time progresses. An integral in the complex plane allows the density to be expressed as a function of height and time. The results are of particular application to tars. F. E. HOARE

536.421 : 536.48

6168. The solid-fluid equilibrium of helium above 5 000 atm. pressure. F. A. HOLLAND, J. A. W. HUGGILL AND G. O. JONES. *Proc. Roy. Soc. A*, **207**, 268–77 (*June* 22, 1951).

The melting curves of He and other low boiling-point substances as determined in the laboratory might be expected to imitate those of other substances at much higher, and unattainable, pressures. This was suggested by Simon, who with Ruhemann and Edwards later determined the melting curves of several low boiling-point substances up to about 5 000 atm. pressure. There was no suggestion of any solid-fluid critical point, although the temperature reached in the case of He was 8× the liquid-vapour critical temperature. In spite of anomalous behaviour at lower temperatures, He is the most suitable model substance for this study, and the melting curve of He has now been followed still further, up to about 50°K and 7 500 atm., with no suggestion of a critical point. Several improvements in technique have been introduced in the present investigation; the results obtained are in complete agreement with the semi-empirical formula originally proposed by Simon, Ruhemann and Edwards. A.

536.422.1

6169. Evaporation and mobility of naphthalene molecules. N. CABRERA. Letter in *Nature, Lond.*, **167**, 766–7 (*May* 12, 1951).

The mean displacement of adsorbed molecules is shown to be 10^{-4}–10^{-6} cm at room temperature, instead of a few mm as deduced by Clancey [Abstr. 7945 (1950).] J. A. FRANKS

536.423.15

6170. Measurement of vapor pressures by means of matched thermistors. A. P. BRADY, H. HUFF AND J. W. MCBAIN. *J. Phys. Coll. Chem.*, **55**, 304–11 (*Feb.*, 1951).

The theory and operation of a modification of the Hills–Baldes vapour-pressure apparatus are described. The thermocouples and galvanometer are replaced by two thermistors incorporated in an a.c. bridge. This leads to greater rapidity and ease of operation, with a sensitivity at least equivalent to the best published thermocouple results. A.

536.423.15

6171. The vapor pressure of zinc in the range 300°–360°C. J. E. VANCE AND C. I. WHITMAN. *J. Chem. Phys.*, **19**, 744–8 (*June*, 1951).

The vapour pressure has been measured using Knudsen's effusion method. The temperature/vapour-pressure relation was found to be $\log_{10} p_{mm} = (-6\,688/T) + 8{\cdot}888$ in the range 300°–360°C. These results are about 20% higher than those previously reported. It is suggested that this difference may be attributed principally to the omission of a probability factor by earlier workers. A.

536.423.15 : 539.155.4

6172. On the accurate determination of vapour densities and molecular masses. W. MUND AND R. COEKELBERGS. *Bull. Acad. Roy. Belge Cl. Sci.*, **37**, 146–54 (*Feb.*, 1951) *In French.*

Describes an experimental method for an accurate determination of vapour densities, and an appropriate method of calculating the results so as to obtain the molecular weight, even in the case when the vapour is slightly associated. An accuracy of 0·2% is claimed. F. LACHMAN

536.46

6173. Combustion of fuel particles. D. B. SPALDING. *Fuel*, **30**, 121–30 (*June*, 1951).

The theory of combustion developed in a previous paper [Abstr. 4922 (1950)] is applied to the combustion of small particles of oil and C under conditions where convection is absent, and extended to the cases of variation of thermal conductivity with temperature and dissociation of the gases. The combustion rates of fuel particles are calculated and compared with the time available for combustion in engines under various conditions. A.

536.48

6174. A thermal switch for use at low temperatures. G. O. JONES. *J. Sci. Instrum.*, **28**, 181 (*June*, 1951).

A method is described by which thermal contact between two parts of an apparatus at low temperatures may be made or broken at will. The device employed requires one external connection leading to a high-vacuum system and source of exchange gas; it has the advantage that it can be used as a self-contained "switch" connecting two points and its operation need not affect any other part of the apparatus. A.

536.48

6175. Adiabatic oscillations in liquid helium. J. E. ROBINSON. Letter in *Phys. Rev.*, **82,** 440 (*May* 1, 1951).

The equations of the 2-fluid model are used to determine the frequency of oscillations of the He II levels in a system of 2 containers connected by a very fine slit or capillary. When the containers are well isolated from each other the frequency is determined more by the fountain effect than by gravitation.

R. B. DINGLE

536.48

6176. Flow of liquid helium through fine channels. G. K. WHITE. *Proc. Phys. Soc., Lond. A*, **64,** 554–8 (*June*, 1951).

The use of etched Cu membranes for studying the flow properties of liquid He is described. In liquid He II the velocity of flow is found to be proportional to the nth power of the pressure difference, where the exponent n has the value 0·22 from 1·15°K to 1·9°K and increases slightly near the λ-point. Some determinations of the viscosity of liquid He I give results in general agreement with earlier work, no indication of non-classical or superfluid flow being apparent either immediately above the λ-point or at higher temperatures. A.

536.48

6177. Pressure gradients in superflow. R. BOWERS AND G. K. WHITE. *Proc. Phys. Soc., Lond. A*, **64,** 558–62 (*June*, 1951).

Earlier work on the pressure gradients existing in a narrow channel through which liquid He II is flowing has been extended by observations on the flow of liquid He II through porous metallic membranes. Using two membranes of only slightly different flow resistance in series, it has been found that almost all the pressure drop associated with the flow occurs across the membrane of higher resistance, the flow through the membrane of lower resistance taking place under almost zero pressure gradient. The phenomenon is compared with a similar effect in film flow and is interpreted in terms of a critical flow rate in liquid He II. A.

536.48 : 530.162

6178. On the quantum hydrodynamics of helium at very low temperatures. I. Bose–Einstein condensation. II. The two fluids. D. MASSIGNON. *C.R. Acad. Sci., Paris*, **232,** 1336–7 (*April* 2); 1407–8 (*April* 9, 1951).

I. The condensation depends on the shape of the container for a gas. II. The density-flow vector defined by the author [Abstr. 735–6 (1950)] for a capillary of fluid is found to separate into two parts so that there is a correspondence to a mixture of fluids. G. J. KYNCH

536.48 : 537.312.62

6179. Non-equilibrium thermodynamics of two-fluid models. S. R. DE GROOT, L. JANSEN AND P. MAZUR. Letter in *Phys. Rev.*, **81,** 1070 (*March* 15, 1951).

Mention is made of results obtained by applying the thermodynamics of irreversible processes to the 2-fluid models of He II and superconductivity.

R. B. DINGLE

536.531 : 621.316.89 : 621.317.39

6180. The design of thermistor thermometers with linear calibration. W. R. BEAKLEY. *J. Sci. Instrum.*, **28,** 176–9 (*June*, 1951).

Under certain circuit conditions a current or voltage may be obtained which varies almost exactly linearly with the temperature of a thermistor. Equations are given from which may be calculated (*a*) the extent of the range of temperature within which the departure from linearity is less than a specified value; (*b*) the circuit conditions which provide optimum linearity; (*c*) the sensitivity of the circuit in terms of current change per unit temperature change; and (*d*) the maximum permissible current through the thermistor. A.

536.55 : 537.523.5

6181. Investigation of the temperature of the metallic arc from the molecular spectrum of hydroxyl. V. D. MIKHALEVSKIĬ AND V. V. PROKOFEVA. *J. Exp. Theor. Phys., USSR*, **20,** 584–93 (*July*, 1950) *In Russian.*

The temperature of the metallic arc was determined from the intensity distribution of the lines of the Q branch of the OH-band λ3064 Å. The temperature was also determined from the atom lines Fe II. Reasons are given for the discrepancy of the results of the two measurements. The investigation of the radial distribution of the line intensities and arc temperatures furnishes an explanation for the lower temperature deduced from the OH-spectrum. Investigation showed that arc temperature deduced from OH-band λ3064 Å is not that of an arc burning in air. (1) An arc burning in H_2O vapour is characterized by quite different electric and temperature parameters from that in air. Electric discharge in electro-negative gas atmosphere (as is H_2O vapour) is difficult to maintain and it requires higher energies and temperatures. Voltampere characteristics show that increase of field gradient of the arc in H_2O vapour liberates energy 10% greater than in air, and this raises discharge temperature. Temp. measurement from spark lines of Fe II (present in electrodes) reveal that the H_2O-arc temp. is 10% higher than the air-arc temp. (2) Dissociation energy of OH-molecule is not high and in the central, hottest parts of arc there is less OH than in the outer parts of the column. Measurement of OH-band temp. from luminosity of whole discharge, is mainly of discharge border zones temp., which is low. There are thus two opposite errors in OH-band measurements which may sometimes compensate each other. B. F. KRAUS

536.63 : 538.22

6182. True specific heat of zinc, nickel and cobalt ferrites. L. BOCHIROL. *C.R. Acad. Sci., Paris*, **232,** 1474–7 (*April* 16, 1951) *In French.*

Reports measurements between 100° and 700°C, covering the Curie point range, with its associated λ-point, for Ni and Co ferrites. E. P. WOHLFARTH

THERMODYNAMICS 536.7/.8

536.7

6183. Potential energy in thermomechanics. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge. Cl. Sci.*, **36** (*No.* 12) 984–91 (1950) *In French.*

External potential energy is introduced into the

equations of thermomechanics. This readily enables the influence of a field of force on the affinity of a molecular transformation to be found. F. E. HOARE

536.7

6184. On the thermomechanics of irreversible phenomena. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge. Cl. Sci.*, **36** (*No.* 12) 962–83 (1950) *In French.*

A brief exposition of the theory of irreversible processes in a form slightly different from that given formerly by the author. The deductions have been made more general and new details added. F. E. HOARE

536.7

6185. On the affinity of fluid flow. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belge. Cl. Sci.*, **37**, 126–37 (*Feb.*, 1951) *In French.*

The author considers affinity of flow and substitutes a more logical definition than that given previously. The role of velocity of flow in the equations of thermo-mechanics is then examined and an application to a simple case considered. F. E. HOARE

536.7

6186. Hydrogen at high temperatures. I. BREDT. *Z. Naturforsch.*, **6a**, 103–12 (*Feb.*, 1951) *In German.*

The properties of H_2 as a suitable working substance for a high-temperature heat engine are discussed quantitatively. Formulae for the specific heat at constant pressure, the enthalpy, the degrees of dissociation and ionization, and entropy of H_2 between 10^3–10^4 °K and 10^{-3}–10^6 atm. are stated and used to obtain numerical values for the physical properties. These are shown graphically. The boiler temperatures and jet velocities for a H-rocket, attainable under various equilibrium conditions, are discussed and given in terms of the energy of the H_2 in the boiler. The energy is expressed as an incompletely defined "Aufheizungsenthalpie" $J = pV + Q_{tr} + Q_{rot} + Q_{osc} + Q_{dis} + Q_{ion}$. S. WEINTROUB

536.7 : 530.162 : 536.42

6187. Statistical mechanics of phase change. I. A. MÜNSTER. *Z. Naturforsch.*, **6a**, 139–51 (*March*, 1951) *In German.*

A consideration of the thermodynamics of systems at constant temperature and at constant volume. For all order-one changes a critical point must exist. The condensation theory of Mayer–Born–Fuchs is discussed in the light of the general theory. T. C. TOYE

536.71 : 532.7

6188. Equation of state for liquids. F. MASLAN AND E. ABERTH. Letter in *J. Chem. Phys.*, **19**, 658–9 (*May*, 1951).

The reduced equation of states contains a parameter Λ^* which measures essentially the influence of quantum mechanics on the phenomenon considered. [Abstr. 2460 (1948), 1441 (1949)]. The authors have applied this theory to a number of gases and consider that other parameters need to be included which will take into account the distributions of energy in the more complex molecules. T. C. TOYE

536.752 : 537.567

6189. Entropy of a mixture of excited and ionized gases in equilibrium. P. DUMEZIL-CURIEN. *C.R. Acad. Sci., Paris*, **232**, 1471–2 (*April* 16, 1951) *In French.*

Generalizes the expression obtained by Schatzman [Abstr. 4746 (1949)] who neglected the excited states of the atoms and ions. P. M. DAVIDSON

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.122

6190. A model interpretation of the extra magnetic moment of the electron. J. BRANDMÜLLER. Letter in *Naturwissenschaften*, **38** (*No.* 6) 139 (1951) *In German.*

On the "Zitterbewegung" of a relativistic electron interpreted as a rotation in a circle of radius $\hbar/2mc$ [Hönl, *Ann. Phys., Lpz.*, **33**, 565 (1938)] is superimposed a "Hyperzitterbewegung" in a circle $e^2/2mc^2$. This gives the extra magnetic moment (apart from a factor 2) and predicts a small extra electron spin.

W. J. SWIATECKI

ELECTROSTATICS . DIELECTRICS 537.2

537.221 : 539.621

Dry friction and electric contact at small displacements. *See Abstr.* 6520

537.224 : 621.3.011.4 : 621.319.4

6191. The stability of mica standards of capacitance. G. H. RAYNER AND L. H. FORD. *J. Sci. Instrum.*, **28**, 168–71 (*June*, 1951).

The stability of the National Physical Laboratory substandard mica capacitors since their manufacture in 1932 is described, with special attention to the period 1944–50. The best section, of 0·1 μF, has remained within $\pm$ 1 part in 10 000 of its nominal value on capacitance throughout, and its power factor has shown barely detectable changes over the period 1944–50. The worst section, of 0·01 μF, has changed in capacitance by 1 part in 1 000 since 1936. Seasonal changes, which are due to atmospheric humidity, have been found in both capacitance and power factor on the smaller capacitors; this effect has been confirmed by tests on a 0·01 μF capacitor in dry and wet atmospheres. A.

537.226 : 538.566.2

6192. The electric susceptibility of water drops due to ionic polarisation. O. TUKIZI. *J. Phys. Soc. Japan*, **6**, 51–5 (*Jan.–Feb.*, 1951).

A new formula for the susceptibility of a water drop is developed in which account is taken of the ionic polarization within the drop. It is suggested that the analysis might provide a satisfactory explanation for tropospheric radiowave reflection.

W. J. G. BEYNON

537.226.1

6193. Theory of polarization of dipolar liquids and gases in a constant electric field. I. A. A. BORGARDT AND B. N. FINKELSHTEĬN. *J. Exp. Theor. Phys., USSR*, **20**, 887–92 (*Oct.*, 1950) *In Russian.*

In calculating the orientating polarization of dipolar gases and liquids in a constant electric field, a statistical distribution of the internal field was assumed. The averaging over the various directions considered the deviation of the space distribution from the isotropic one, and also elastic polarization of the

molecules in the internal field. The formula for the dielectric constant of dipolar liquids contains only molecular constants and describes the temperature relation of ε correctly. (Calculations for chloroform between $-40°$ and $+100°$C.) Syrkin's conclusion that ε of polar liquids, except some prone to associating (water, alcohols) is determined by the dipole moment of the free molecule is thus confirmed. The orientating polarization in non-associating dipolar liquids does, therefore, not depend on the structure of the nearest order. Also, calculation of ε in this case does not require assumption of any special model or introduction of such quantities as the effective dipolar moment of the co-ordination group. B. F. KRAUS

537.226.1 : 536.75

6194. Processes in dielectrics containing free charges. The entropy of electrostatic systems. B. BREYER AND F. GUTMANN. *J. Proc. Roy. Soc. N.S.W.*, **83** (*No.* 1) 66–74 (1949).

The influence of space charges in a dielectric is investigated theoretically, and the free electrostatic energy, capable of doing reversible work, is calculated, yielding an expression for the effective dielectric constant of a medium containing free charges. A correspondence between a number of thermal and electrical quantities is established. It is shown that a space-charge filled capacitor may still be loss free, if the sum total of the free charges in the dielectric is constant or linearly proportional to the potential difference across the capacitor. E. RUSHTON

537.226.1.08

6195. The measurement of dielectric constants of conducting liquids. J. O'M. BOCKRIS AND J. BOWLER-REED. *Brit. J. Appl. Phys.*, **2**, 74–6 (*March*, 1951).

The measured force exerted between two plates immersed in a liquid when maintained at a known alternating potential is proportional to the dielectric constant of the liquid, and is independent of any conductance or phase change; this has been used to obtain values of the constant for NaCl and tetraethylammonium iodide solutions up to 0·01 N; the apparatus is described. It may be used to determine the dielectric constants of conducting liquids, such as electrolytic solutions, up to a specific conductance of $1{\cdot}2\times10^{-3}$ mho-cm, with a reproducibility of $\pm1\%$. A.

537.226.2

6196. Dielectric properties of the water of crystallization. K. KAMIYOSHI AND T. MIYAMOTO. *Sci. Rep. Res. Inst., Tôhoku Univ., Ser. A*, **2**, 370–9 (*April*, 1950).

Dielectric constants of 6 kinds of compounds, including the water of crystallization, and of their 6 anhydrous compounds were measured, and it has been found that the additivity relation of molar polarization holds for the water of crystallization, and that the molar polarization per water of crystallization, when calculated by the Clausius–Mosotti equation, is constant within 5% error. Powder samples are employed for the measurement of these dielectric constants; the true dielectric constants are calculated by the new deduction formula. Temperature variations of these constants have been also observed. A.

537.226.2

6197. Dielectric permittivity of ferroelectrics. I. S. K. KULKARNI DZHATKAR AND B. R. YATIRADZHA IENGAR. *J. Exp. Theor. Phys., USSR*, **20**, 594–606 (*July*, 1950) *In Russian.*

A new equation, into which a "characteristic temperature" θ was introduced (this being temperature of absorption maximum), permits of calculating the dipole moments of a number of substances, including ferroelectrics (Seignette salt, TiO_2, Ba, Sr and Ca titanates, and silica) from dielectric constants. The formula is $(\varepsilon - n^2)M/d = 4\pi\mu^2/k(T-\theta)$, where M = molecular weight, n = internal field coeff., d = density and μ = dipole moment. It is derived from Jatkar's formula [Abstr. 1115 (1944)] by introduction of θ. For Seignette salt, which has two Curie temperatures ($-15°$ and $+23°$), the moment in both regions was found identical ($2{\cdot}4D$), for TiO_2 $3{\cdot}3D$ = electron charge × distance (co-ordination number), Ti–O $\theta SiO_2 = 0$; for Ba titanate $9{\cdot}5D$, for Ca titanate $6{\cdot}0D$ and for Sr titanate 7·1, which are near to the resultant vector calculated for $MTiO_3$ cell, where M = Ba, Ca or Sr, for values of distance M–O equal to 2·53, 2·39 and 2·75 Å, respectively. The moment of $SiO_2 = 1{\cdot}0D$ ($\theta = 575°$C, temp. of α–β quartz conversion) is the vector sum of two tetrahedrally inclined bond moments Si–O, each equal to $0{\cdot}86D$. The actual free bond moment of Si–O is $0{\cdot}86 \times 2$ (co-ordination number) $= 1{\cdot}72D$, i.e. sufficiently close to the calculated figure $1{\cdot}62D$. $\mu = ed[Z_{Si}/(Z_{Si} + Z_O)]n$, where Z is atomic number and $n = 1/3$. B. F. KRAUS

537.226.2

6198. Dielectric permittivity of ferroelectrics. II. KH_2PO_4, $NH_4H_2PO_4$, KH_2AsO_4, $NH_4H_2AsO_4$. S. K. KULKARNI DZHATKAR AND S. N. GOPALASVAMI. *J. Exp. Theor. Phys., USSR*, **20**, 607–8 (*July*, 1950) *In Russian.*

The above substances were found to be ferroelectrics. From measurement of their dielectric constant the transition temperatures satisfying Jatkar's equation (see preceding Abstr.) were found as 115·91, 155 and 220°K, respectively. These molecules have the dipole moments 2·04, 2·03, 2·77, 2·74, respectively, which proves an influence of the K or NH_4-ion on the value of the moment. B. F. KRAUS

537.226.2

6199. Dielectric permittivity of associating liquids. S. K. KULKARNI DZHATKAR AND B. R. YATIRADZHA IENGAR. *J. Exp. Theor. Phys., USSR*, **20**, 693–704 (*Aug.*, 1950) *In Russian.*

Dipole moments of associating liquids for various temperatures are calculated on the formula $(\varepsilon - n^2)M/d = 4\pi N\mu^2/k(T-\theta)$ suggested by the authors for ferroelectrics (preceding Abstr.). For ethyl, isopropyl, butyl, amyl alcohol, the characteristic temperature coincides with melting point. For water, methyl alcohol, HCN and HF, θ is below melting point. Calculated values of θ at high temperatures tend asymptotically towards values of moments of vapours and dilute solutions. Molecular radii of alcohols calculated correspond to half the length of the linear chain H–O–H which indicates rotation of the whole molecule about the centre of the

chain. For isobutyl alcohol lower value corresponds to a rotation of the spiral-shaped structure; the higher value (4·2) in concentrated solutions corresponds to a rotation of the straight chain. Data of recent measurements of dielectric constant and loss angle of water at various temperatures and frequencies were used for calculating the critical frequency and molecular radius of water by use of a new equation of dielectric dispersion of polar liquids. In agreement with the above value of molecular radius the value 1·4, independent of temperature, was obtained.

B. F. KRAUS

537.226.2

6200. The dielectric constant of polystyrene solutions. P. DEBYE AND F. BUECHE. *J. Phys. Coll. Chem.*, **55**, 235–8 (*Feb.*, 1951).

An attempt has been made to repeat the experiments of Voet on the relation between dielectric constant and concentration of polystyrene–toluene solutions. The results appear to show that no discontinuity exists in the curve. The dielectric constant varies linearly with concentration in such a way as to extrapolate to the dielectric constant of the solid polymer.

A.

537.226.2

6201. Effect of stress on domain structure of tungsten trioxide WO_3. R. UEDA AND T. ICHINOKAWA. Note in *J. Phys. Soc. Japan*, **6**, 122–3 (*March–April*, 1951).

Temperature and electric field have little effect on the domain structure, but stress causes the domain components to contract and the twin boundary to disappear until the domain structure is no longer visible under the microscope. On removal of the stress, the domain pattern reappears but the original structure is not regained.

E. RUSHTON

537.226.2

6202. Volume change at three transitions in $BaTiO_3$ ceramics. G. SHIRANE AND A. TAKEDA. Note in *J. Phys. Soc. Japan*, **6**, 128–9 (*March–April*, 1951).

The linear coefficient of expansion in $BaTiO_3$ changes in value on passing through the three temperatures −77°, 16° and 125°c at which phase transitions occur in this material.

E. RUSHTON

537.226.2

6203. Lithium ammonium tartrate monohydrate, a new ferroelectric crystal. W. J. MERZ. Letter in *Phys. Rev.*, **82**, 562 (*May* 15, 1951).

The salt shows typical ferroelectric properties, the ferroelectric direction being along the *b*-axis and the Curie temperature being about −110°c.

E. RUSHTON

537.226.3

6204. A note on the dielectric dispersion in polycrystalline materials. E. BILLIG AND K. W. PLESSNER. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 361–3 (*April*, 1951).

The model of non-metallic solids in which grains of the material are considered to be surrounded by boundaries of high resistance shunted by a capacitance, is elaborated by including the capacitance of the grains (important at the higher frequencies) in the calculations. The apparent permittivity and loss angle then vary in a similar manner to the case of Debye dispersion.

C. A. HOGARTH

537.226.33

6205. Temperature hysteresis of electric conductivity of hard dielectrics with relaxation polarization. G. I. SKANAVI, A. I. DEMESHINA AND A. G. CHRELASHVILI. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 5) 673–6 (1951) *In Russian.*

The cycle of heating-cooling under voltage decreases dielectric permeability under low frequencies by 10–15%, does not change the loss angle, and decreases specific electric conductivity; it causes such changes in the material that a repeat cycle gives the loop of temperature hysteresis of electric conductivity with a much smaller area. Hypothetical causes are outlined.

J. LUKASZEWICZ

537.228.3

6206. Tensor form of piezo-optic and electro-optic equations. L. VALENTA. *Acta Cryst.*, **4**, 237–9 (*May*, 1951).

The relations for piezo-optic and electro-optic phenomena are expressed in tensor form by means of only one equation. The possible existence is shown of refraction of a kind similar to Hamilton's conical refraction which might be observed in a crystal placed on alternating electric field. The interpretation of this effect is, however, physically essentially different.

A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311 : 536.48 : 538.63

Electrical resistance of some ferromagnetic metals [and alloys] in a magnetic field at low temperatures. *See Abstr.* 6368

537.311.1 : 539.4.016

6207. Level of the electric fluctuations in some metals after tempering. E. YA. PUMPER. *Dokl. Akad. Nauk, USSR*, **68** (*No.* 2) 277 (1949) *In Russian.*

537.311.33

6208. Studies on selenium and its alloys (Report I) Physical properties of selenium. T. SATO AND H. KANEKO. *Techn. Rep. Tôhoku Univ.*, **14** (*No.* 2) 45–54 (1949).

The crystallization of Se is discussed in some detail, the vitreous and trigonal metallic forms being of greatest technical interest. The exothermic nature of the transition to crystalline form is demonstrated; temperature *v.* time heating and cooling curves are given. Photo-micrographs of the crystallization process are given and show the formation of nuclei. It is found that $x = Kt^3$, where x is the mass of crystalline material and t is the time, and that deviations from this law occur once the nuclei have touched. The specific gravity as found by the powder method is given as 4·81 for metallic and 4·26 for vitreous Se. The thermal expansion coefficient is given as $5 \cdot 59°c^{-1}$ for vitreous Se and 3·18 at 0 to 50°c, rising to 5·29 at 150 to 200°c for metallic Se. The specific heat is

about 0·16–0·17 cal gm^{-1} $°C^{-1}$ for metallic and 0·1 cal gm^{-1} $°C^{-1}$ for vitreous Se. The effect of heat treatment on electrical resistance is examined and it is shown that the higher the heating temperature the higher is the minimum resistance. The conduction process is considered due to vacant lattice sites and the thermal equilibrium of this disorder process is said to explain the results concerning heat treatment. Some results for electrical properties after heating to much higher temperatures are given. C. A. HOGARTH

537.311.33

6209. Measurements on the electrical resistivity of iron films at low temperatures. A. VAN ITTERBEEK, L. DE GREVE AND R. LAMBEIR. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 1) 7 *pp.* (1950).

It was previously observed that thin films of Ni, 50×10^{-7} cm, may have semiconducting properties. For the thicker films electrical resistance as a function of temperature shows a minimum. From ordinary temperatures down to low temperatures the temperature coefficient changes from positive to negative at a given temperature which depends strongly on the thickness of film and on the gas in which it was sputtered, and the thicker the film, the lower is the change-over temperature. The temperature variation of resistance is given by $R = AT^{-n}$. Iron films were made by sputtering Kahlbaum iron in H_2 at 10^{-7} cm Hg. Electrical properties are similar to those for Ni, but the film thickness can be even higher. Again, $\log R \propto \log T$. These films have a possible application in thermometry near the absolute zero.

C. A. HOGARTH

537.311.33

6210. On the theory of elementary excitations in a weak non-ideal electron-gas in crystals. V. L. BONCH-BRUEVICH AND S. V. TYABLIKOV. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 6) 817–19 (1951) *In Russian.*

The energy of weakly excited states is the sum of elementary excitations, without interactions, which obey Fermi statistics. The effective masses depend on the electron density in the lattice. Electronic interaction can be determined in some problems of semiconductors. J. JACOBS

537.311.33

6211. Electric conductivity of semi-conductors. T. HIBI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 150–5 (*Feb.*, 1950).

In this paper the electric conductivity of semiconductors was numerically calculated on Wilson's theory of semiconductors without any assumption, on a new generalized theory of semiconductors assuming an electron obeys Fermi-distribution, and on Nijboer's theory considering the crystal imperfection without any assumption. Results are compared with experiment. A.

537.311.33

6212. Electrical conductivity of lead glasses. K. S. EVSTROPEV, A. YA. KUZNETSOV AND I. G. MELNIKOVA. *J. Tech. Phys., USSR*, **21** (*No.* 1) 104–11 (1951). *In Russian.*

Specific conductivities of glasses of the PbO–SiO_2 system were measured in the temperature interval 60–300°C. The temperature relation is satisfactorily represented by $\log k = a - b/T$. Increase of PbO content leads to higher conductivity. The logarithm of conductivity varies as the chemical composition expressed in molecular percents. The isothermals of the logarithm of the conductivity have kinks at the points corresponding to the lead metasilicate. E.R.A.

537.311.3

6213. The effect of pressure on the electrical resistance of certain semi-conductors. P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.*, **79** (*No.* 3) 127–48 (*April*, 1951).

The resistance of a large number of semiconductors as a function of hydrostatic pressure P is measured at 25°c, 100°c and 200°c, up to pressures of 50 000 kg cm^{-2} (40 000 for some materials at 200°c). For the polycrystalline oxidic materials specific resistances ρ were calculated; although a bridge method of measurement was used, it was considered that the extremely high pressures reduced the contact and intergranular resistances. Ag_2SO_4 was used as the material for the transmission of pressure: at the temperatures and pressures used it was effectively an insulator. The experiments on high purity n- and p-type Si and Ge were of much higher accuracy than those on oxides since the specimens were more nearly crystalline, and also since a current-potential method of measurement was used. For U_3O_8, V_2O_5 and NiO, ρ decreases steadily with increase of P at all temperatures. With Mn_3O_4 there is an increase in ρ with P at 25° but a decrease at higher temperatures; with ZnO there is a decrease in ρ with increase of P at 25° and 100°, but an increase with marked hysteresis effects at 200°, and similar properties are exhibited by TiO_2. Most specimens showed hysteresis effects at 25°c, probably because the pressures were not completely hydrostatic. For n-type Ge at 25°c the relative resistance R/R_0 increases with P, whereas for p-type Ge there is a decrease. For n-type Si ($\rho = 3{\cdot}9$ ohm cm) at 25°c, there is an increase in R/R_0, with P, followed by a decrease; for p-type Si the maximum value of R/R_0 occurs at higher pressures.

C. A. HOGARTH

537.311.33

6214. The parameters of simple excess semiconductors. P. T. LANDSBERG, R. W. MACKAY AND A. D. MCDONALD. *Proc. Phys. Soc., Lond. A*, **64**, 476–80 (*May*, 1951).

Graphical information is given which facilitates the evaluation of the parameters entering into the theory of simple excess semiconductors. A.

537.311.33

6215. Semiconducting properties of thoria *in vacuo*. G. MESNARD. *C.R. Acad. Sci., Paris*, **232**, 1744–6 (*May* 7, 1951) *In French.*

The experimental tubes consisted of two parallel wires, 0·1 mm dia., and 0·25 mm apart, completely enclosed in a cylinder of deposited thoria. The wires served as either electrodes or (on a.c.) heating elements. Resistances by a.c. and d.c. methods, thermoelectric effects, and thermal conduction, were investigated for the range 1 200–2 200°K. The effects of vacuum treatment at these high temperatures were very marked and indicated that initially the thoria was an oxidation semiconductor. Ohm's law was

not always obeyed, rectification effects were observed at the metal/thoria interface, and evidence for some ionic motion was obtained. Two ranges of activation energies, 1- and 3-eV, were found. For the medium temperatures the values of thermo-electric power were several mV/°C, and the effects are explained in terms of electrons emitted by the thoria being captured by the W at the interface. C. A. HOGARTH

537.311.33

6216. Application of the image-force model to the theory of contact rectification and of rectifier breakdown. E. BILLIG. *Proc. Roy. Soc. A*, **207**, 156–81 (*June* 22, 1951).

The assumptions underlying the current diffusion theory of rectification are critically examined. By replacing the familiar step-like potential distribution at the rectifying junction by one with a more gradual rise in potential, the theory is extended to cover the range of high inverse voltages, where existing theories fail. On the application of an inverse voltage the height of the barrier is reduced and the leakage current increases. The subsequent rise in temperature in turn causes a further increase in current. With sufficiently high inverse voltages this process can eventually lead to the onset of intrinsic conduction or to thermal instability long before the barrier has been reduced completely. The theory is applied to the Se plate rectifier and predicts the onset of thermal instability with reasonable accuracy. As this instability is one of the limiting factors of rectifier operation it is shown that the choice of materials which make up useful rectifying junctions is restricted to those combining a reasonably large barrier height with a fairly low electronic conductivity of the semiconductor. A.

537.311.33 : 537.312.5

6217. Origin of a time-lag effect in selenium rectifiers. K. LEHOVEC. Letter in *Nature, Lond.*, **167**, 522–3 (*March* 31, 1951).

To determine whether the change of impedance in the reverse direction of a Se rectifier, after application of a voltage, is an electronic process or due to ionic migration, a rectifier with a transparent Cd counter-electrode was made. It was found that use of a light pulse after application of a voltage assisted in the recovery of the rectifier, and that the effect is greater with light of higher intensities. No photo-voltaic effects were observed. It is concluded that since light sources of the type used could not be expected to affect the motion of ions in Se, the forming and creep processes are electronic in nature. C. A. HOGARTH

537.311.33 : 537.32 : 538.63

6218. Electric resistance, Hall effect, magneto-resistance and Seebeck effect in a pure tellurium film. T. FUKUROI, S. TANUMA AND S. TOBISAWA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **1**, 365–73 (*Dec.*, 1949).

Measurements were carried out on Te films, deposited by evaporation on glass plates, between −195° and 60°C. The film thickness was determined either from the weight deposited (d_ρ) or from the resistance (d_σ)$_T$. For $d_\rho < 1\mu$, $d_\rho/d_\sigma \sim 1$; for higher values d_σ remains constant, probably due to an amorphous surface layer which does not participate in conduction. The temperature variation of resistance was measured, the temperature coefficient being negative. The Hall coefficient is positive and proportional to d_σ; the change of resistance in a magnetic field H is proportional to H^2; the thermo-electric power (against Al) is positive with an anomalous change of slope at −100°C. The results are briefly discussed from the standpoint of semiconductor theory. E. P. WOHLFARTH

537.311.35

6219. Electrical properties of some carbon black-oil suspensions. M. J. FORSTER AND D. J. MEAD. *J. Appl. Phys.*, **22**, 705–10 (*June*, 1951).

The d.c. conductivity and a.c. (1 000 c/s) properties of suspensions of R-40 carbon black in transformer, silicone and linseed oils, and suspensions of Shawinigan black in linseed oil, were studied as functions of time, carbon black concentrations and rotational speed of test cell. The d.c. conductivity was also studied as a function of voltage. Immediately after agitating the suspension, both a.c. and d.c. conductivities increase rapidly with time, then level off and approach a saturation value. For the d.c. conductivity, this value increases with increasing voltage in all suspensions studied except the highest concentrations (10% by weight), which obey Ohm's law. The rate of approach to saturation is independent of voltage but depends on carbon black concentration. Increasing the concentration increases the conductivity. Increasing the speed of rotation decreases the conductivity. Form factors for the carbon black particles are calculated from the dynamic values of the dielectric constant by Voet's method. Agglomeration factors are then determined. At low speeds the agglomeration factor decreases rapidly with increasing speed. At higher speeds it approaches unity asymptotically. A.

537.312

6220. Variation of the conductivity of cadmium sulphide under irradiation with electrons. V. A. ARKHANGELSKAYA AND A. M. BONCH-BRUEVICH. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 2) 229–32 (1951) *In Russian.*

The cathodic conductivity under electron bombardment was discovered by Kronig on Se [*Phys. Rev.*, **24**, 377 (1924)]. The kinetics of the variation of the induced conductivity of both crystalline and amorphous Se could not be explained. An investigation on CdS was made by the authors with an intermittent electron beam, and the variations of the conductivity automatically recorded by c.r.o. The rise time of the electronic pulse was 10^{-7} sec. The c.r.o. had an exponential time base and the method of analysis used was that of the "partial times." The absolute value of the dark conductivity of the CdS crystal was $\sim 5\times10^{-11}$ ohm^{-1}; the electron velocity was kept at 2 000 V. The drop of the value of the induced conductivity was slowed down by increasing the density of the electron current. Under a constant electron current the period of the induced conductivity remained constant after the initial reduction to about ½ the initial value, taking about 10–15 min. The conclusion derived from the graphs is that the kinetics of the excitation of the cathodic conductivity

by electron beams follows approximately a bimolecular law, with a deviation reminiscent of the degeneration of the bimolecular law of photoconductivity in the region of low luminescence of the specimen. B. F. KRAUS

537.312.5

6221. "Exciton" nature of the light absorption and the contamination photoconductivity. V. P. ZHUZE AND S. M. RYVKIN. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 2) 241–4 (1951) *In Russian.*

In order to eliminate a contradiction present in the theory advanced by the authors [Abstr. 4988 (1950); 1840 (1951)] it is proposed to assume that the transition of electrons from the M levels into the upper zone is not due to direct interaction between light quanta and the atoms of the contaminating substance, but that it is the secondary result of the absorption of light by the fundamental crystal lattice. [The "exciton" theory was originated by Frenkel (*J. Exp. Theor. Phys., USSR*, **6**, 647 (1936)]. F. LACHMAN

537.312.5

6222. New image-converter-type tubes for use with standard electron multiplier photocells. M. E. AMDURSKY, W. O. REED AND S. PAKSWER. Letter in *J. Opt. Soc. Amer.*, **41**, 361–2 (*May*, 1951).

The spectral distribution of sources in the red and infrared is investigated by means of photo-multipliers with a S-4 cathode whose red-threshold (6 200 Å) is extended by using a photoelectric transducer (image converter) consisting of a S-1 cathode and a blue fluorescing screen in front of a standard photomultiplier. W. SUMMER

537.312.5

6223. Preparation of photoconductive cadmium sulphide. R. E. AITCHISON. Letter in *Nature, Lond.*, **167**, 812–13 (*May* 19, 1951).

Photoconducting CdS is prepared from an aqueous solution of $CdSO_4$. Surfaces of any desired area and up to 5 μ thickness can be prepared. W. SUMMER

537.312.5

6224. The photoconductivity of some triphenylmethane dyes. R. C. NELSON. Letter in *J. Chem. Phys.*, **19**, 798 (*June*, 1951).

Only basic dyes having coloured cations are photoconductive. Previous work is critically discussed and an explanation is suggested for the mechanism of photoconduction. W. SUMMER

537.312.5 : 537.311.33

6225. Relaxation of the photoconductivity of semiconductors. D. B. GUREVICH, N. A. TOLSTOĬ AND P. P. FEOFILOV. *J. Exp. Theor. Phys., USSR*, **20**, 769–82 (*Sept.*, 1950) *In Russian.*

Photoresistances may be divided into 2 groups: (A) with exponential law of decay of photoconductivity; and (B) with hyperbolic decay law. (A) "Exponential" photoconductors: (1) stationary photoconductivity $\propto$ intensity of exciting light ($\Delta\sigma_0 \sim E$); (2) dark conductivity relatively high (1–2 orders higher than photoconductivity in "exponential" interval); (3) laws of increase and decrease of photoconductivity $\Delta\sigma = \Delta\sigma_0(1 - e^{-t/\tau})$ and $\Delta\sigma = \Delta\sigma_0 e^{-t/\tau}$, where τ in both cases equal and indep. of E; (4) temperature relation $1/\tau$ coincides with that of dark conductivity, according to formul $1/\tau \sim \sigma \sim e^{-u/kT}$; (5) the above properties are th simplest for this class of photoresistances, actua substances showing certain deviations. Examples c exponential photoresist. Cu_2O, CdS at high temps (B) Hyperbolic photoresistances: (1) stationary photc conductivity $\Delta\sigma_0 \sim \sqrt{(E)}$ (E intensity of excitin light); (2) dark photocurrent not appreciable (3) decay law $\Delta\sigma = \Delta\sigma_0/(1 + \alpha t)^\alpha$ where $\alpha \neq f(E)$ whilst $a \sim \sqrt{(E)}$; (4) increase of photocurrent ma be exponential, τ in exponent being $\sim 1/\sqrt{(E$ Examples are Bi_2S_3, Se, Tl_2S, InSe, CdS at lo temperatures. CdS and some Se specimens are th most nearly "ideal." B. F. KRAU

537.312.5 : 548.0 : 535.37

The ionization mechanism and the temperatur dependence of photoconductivity and luminescence c crystals. *See Abstr.* 6136

537.312.

6226. On the variation of the electrical resistance c pure metals at the melting point. H. GERSTENKOR AND F. SAUTER. *Naturwissenschaften*, **38** (*No.* 158–9 (1951) *In German.*

Changes in the structure of low resistivity meta in the neighbourhood of the melting point, as evince by line-broadening of X-rays, are discussed in relatio to the resultant increase in electrical resistivity as th solid melts. C. A. HOGART

537.312.6

6227. High frequency resistance and distortion of weak a.c. superimposed on a strong d.c. in a supe conductor. J. GEISS. *Ann. Phys., Lpz.*, **9** (*No.* 1) 40– (1951) *In German.*

For a non-linear form of the London equation designed to take into account a possible maximu current density (such as is required by Heisenberg theory [Abstr. 3203 (1947)]), it is shown that for rel tively low frequencies the resistance of a thick wi in the superconducting state to a weak a.c. is modifie by the presence of a superimposed strong d.c. two-fluid model is assumed with the "norma current obeying Ohm's law. D. SHOENBER

537.312.6

6228. Results of the generalized phenomenologic theory of superconductivity. J. GEISS. *Z. Phys.*, **1** (*No.* 4) 449–82 (1951) *In German.*

The effect of substituting for the current density in the London equations a vector G which is a functio of J is investigated in two limiting cases. First it assumed that G depends non-linearly on J but h the same direction, and the current and field distr butions in a semi-infinite solid, a plate and a wi are investigated for the case where there is a maximu current density. Second, the consequences of linear tensor relation between G and J are work out for the current and field distribution in a wire. D. SHOENBE

537.312

6229. The influence of the stressed state of a wi on its electrical resistance. E. A. CHAKHMAKHSAZYA *J. Tech. Phys., USSR*, **21** (*No.* 1) 32–8 (1951) *In Russia*

The causes of the resistance variation in time of manganin wire (coil) are discussed. The stabil

of the resistance value of the coil after heat treatment is mainly determined by the stresses in the wire set up during its winding on to a former. Constant manganin resistance coils can be obtained by a heat treatment assuring a complete transition of the elastic deformation of the wire into a plastic one during the temperature rise of the coil. E.R.A.

537.312.9 : 539.893

6230. The electric resistance to 30,000 kg/cm² of twenty nine metals and intermetallic compounds. P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.*, **79** (*No.* 3) 149–79 (*April*, 1951).

Refinements in the method of applying and recording higher pressures have enabled results to be obtained on more metals than previously reported [*Proc. Amer. Acad., Arts Sci.*, **72**, 157–205 (1938)]. The results are of great theoretical value in so far as the compressibilities over the same pressure range are also known for the same specimens. Most metals show a decrease in resistance with increasing pressure but several show an increase in resistance up to a certain value of pressure followed by a decrease, such behaviour indicating a probable phase change in the material. Some, such as Ce, exhibit anomalous effects, and in some cases marked hysteresis effects may be observed. C. A. HOGARTH

537.32 : 537.311.33

6231. Dependence of the coefficient of the thermo-e.m.f. in semiconductors on the temperature difference of the junctions (On Henisch's, Schweikert's and Rode's papers). B. I. BOLTAKS. *J. Tech. Phys., USSR*, **20**, 1039–48 (*Sept.*, 1950) *In Russian.*

See Abstr. 4798 (1949); *Ann. Phys. Lpz.* **34**, 250 (1939); *ibid.*, 259 (1939). The measurements carried out on TiO_2 and Cu_2O at various temperature differences of the junctions showed that the Henisch "effect" for TiO_2 and the dependence of α on $|T_1 - T_2|$ for Cu_2O have nothing to do with the characteristics of these substances, but are due to experimental shortcomings. Henisch's statement that measurements of the thermo-e.m.f. must not be used for determining the sign of the charge carriers seems to be without foundation. Greatest care has to be taken to ensure that thermocouples measure true temperature of the specimen, viz. that at the points between which thermo-e.m.f. is measured. Thermocouples may be "cemented" into the specimen and used as electrodes for e.m.f. measurements. Alternatively, "point contacts" were used by author. The branches of the thermocouples must not cross above the junctions. Thermo-e.m.f.s should not be measured at very small differences $|T_1 - T_2|$, because of the disproportionate rise of the errors. $|T_1 - T_2|$ should be $\sim 20°$, in order to keep errors negligibly small. The experimental findings agree with the Davydov and Shmushkevich theory of the thermo-e.m.f. [*Uspekhi Fizicheskikh Nauk.*, 24, 21, (1940)]. B. F. KRAUS

537.322.3 : 548.0

6232. Benedicks effect in fine-crystalline metal wires. . DIETRICH. *Z. Phys.*, **129** (*No.* 4) 440–8 (1951) *In German.*

Considers whether a monometallic fine-crystalline wire should show a Benedicks effect (thermoelectric potential difference between two points at the same temperature but with an asymmetric temperature distribution in the region between them). Theory and experiment (described in detail) show that the effect, if present, is very small. P. M. DAVIDSON

537.362 : 532.71

Osmosis in a high frequency electric field. *See Abstr.* 6069

ELECTRIC DISCHARGES 537.52

537.523.3

6233. Positive ion formation in air prior to high-frequency breakdown. R. FATEHCHAND. Letter in *Nature, Lond.*, **167**, 566–7 (*April* 7, 1951).

Describes an air-flow method for detecting pre-breakdown currents (at h.f., 2·5–15 Mc/s) in inhomogeneous field gaps in air and air/CCl_4. Graphical plots of data show the "critical frequency" at which the amplitude of positive ion acceleration $\sim$ the gap width. J. D. CRAGGS

537.523.3

6234. Electrical and optical characteristics of d.c. corona discharge. H. M. GAUNT AND J. D. CRAGGS. Letter in *Nature, Lond.*, **167**, 647–8 (*April*, 1951).

Describes, with representative results, a technique for studying visible radiations from d.c. corona pulses. The temporal variations of radiation and displacement currents may thus be compared. J. D. CRAGGS

537.523.4

6235. Influence of cathode surface layers on minimum sparking potential of air and hydrogen. F. LLEWELLYN JONES AND D. E. DAVIES. *Proc. Phys. Soc., Lond. B*, **64**, 397–404 (*May*, 1951).

Oxide layers on the cathode produced marked irregularities in the Paschen curves for air and hydrogen, especially in the neighbourhood of the minimum V_m. V_m in hydrogen was measured at different stages during the removal of oxide layers from the cathode, and also during the deposition of one metal on another as base. Removal of the oxide layer produced smooth Paschen curves, while a thin film of one metal on a different metal as base gave values of V_m which were not characteristic of either metal in bulk. The deposition of thin metallic films had considerable effect on cathode emission owing to the alteration of the work function. A.

537.523.5

6236. Field strength measurements in water-stabilized heavy loading arcs. F. BURHORN AND H. MAECKER. *Z. Phys.*, **129** (*No.* 4) 369–76 (1951) *In German.*

Gives details of measurements on heavy current arcs passing through a simple water turbine which effectively gives a continuously renewed arc boundary of water. The measurements are of field strength as a function of current (up to 250 A) and arc column dimensions. At 250 A the gradients vary from about 60 V/cm for a 6 mm-dia. discharge path to about 240 V/cm for 1·4 mm-dia. path. J. D. CRAGGS

537.523.5 : 537.527.5

6237. Concerning a method for the measurement of very high temperatures in nearly transparent arc columns. R. W. LARENZ. *Z. Phys.*, **129** (*No.* 3) 327–42 (1951) *In German.*

Gives a theoretical treatment [related in certain respects to the recent work of Bartels on self-absorption in arc columns, Abstr. 2717 (1951)] of the measurement of radial variations in arc temperatures by measurement of the intensity of spectral lines across the projected arc column. J. D. CRAGGS

537.523.5 : 537.527.5

6238. Measurements of column temperature in Gerdien arcs. R. W. LARENZ. *Z. Phys.*, **129** (*No.* 3) 343–64 (1951) *In German.*

The high-current arcs described by Gerdien and Lotz [*Wiss. Veröff. Siemens-Werk.*, **2**, 489 (1922); **14**, 25 (1935)] are stabilized by their passage through a special type of water-cooled orifice. The stabilization thereby effected enables high currents (up to 500 A in the present work) and high axial temps. (up to 35 000°K) to be reached. Measurements of excitation temps. are described in detail, with data on radial variations in intensity of light emission, etc. J. D. CRAGGS

537.523.74 : 621.365.29

6239. The electronic torch and related high frequency phenomena. J. D. COBINE AND D. A. WILBUR. *J. Appl. Phys.*, **22**, 835–41 (*June*, 1951).

Presents the design of a h.f. electronic torch operating at 1 000 Mc/s, and some of the physical characteristics of the gaseous discharge produced. The flame produced by polyatomic gases is capable of melting many refractory materials due to the heat of association of the dissociated molecules. Monatomic gases produce little heat. Probe measurements indicate an electron temperature of the order of 10^5 °K. The gas temperature near the outer edge of the flame appears to be of the order of 3 000°K. A.

537.525.3

6240. Starting potentials of positive and negative coronas with coaxial geometry in pure N_2, pure O_2, and various mixtures at pressures from atmospheric to 27 mm. C. G. MILLER AND L. B. LOEB. *J. Appl. Phys.*, **22**, 740–1 (*June*, 1951).

Consequent to an exhaustive study of coronas with coaxial cylindrical geometry in pure N_2, pure O_2 and mixtures over a considerable pressure range, it has been possible to obtain a consistent set of threshold values as a function of gas type and pressure for the principal current transitions signalling the accepted coronas. Thresholds for the positive wire corona should depend on gas characteristics only, while those of negative wires should reflect the second Townsend coefficients characteristic of the cathode material. Observations indicate that interpretation along this simple line is complicated by two factors. First, some current transitions under different conditions, which were in the past assumed to represent the same corona process, have been found to be different mechanisms. Thus, in pure N_2 positive wire corona is not a gas-determined process but a cathode-dependent mechanism, while in pure O_2 the corona is a gas-dependent process but of the streamer type and not of the burst pulse type. Secondly, all thresholds o the characteristic negative wire corona transitions d not represent a secondary mechanism characterist of the cathode surface. These transitions are a preceded by a low order Townsend discharge whos threshold passes unnoticed but is characteristic of th initial cathode state. The commonly noted threshol is determined by a conditioning process which ma depend on current density, duration of bombardmen and the composition of the gas. While the dat yielded by the antecedent studies permits of inte pretation in the present system of gases, this stud also indicates that a correct interpretation of relativ starting potentials of positive and negative wi coronas requires an extensive investigation of th basic nature of the coronas before it is attempted

537.525

6241. Mechanism of secondary ionization in lov pressure breakdown in hydrogen. F. LLEWELLY JONES AND D. E. DAVIES. *Proc. Phys. Soc., Lond. B* **64**, 519–27 (*June*, 1951).

The breakdown mechanism was investigated b examining the dependence of the shape of the cathod emission (ω/α, X/p) curves on the deposition o electro-positive or electro-negative atoms on cathode of Ni, Al, Ag, Cu and Mo. X is the electric intensit and p the gas pressure at about 15°C, and ω is th generalized secondary ionization coefficient whic includes processes of cathode emission due to impa of positive ions, of excited atoms and of photon generated in the ionization current; α is the prima ionization coefficient due to the electrons. Depositio of positive atoms on the cathode produced shar photoelectric peaks in the curves in the regio $X/p \simeq 150$ V/cm.mm Hg, but ω/α was not greatl affected at higher values of X/p. These results a analysed in terms of the varying effective wor function of the surface due to the deposition of atom It is concluded that the high photoelectric emissio from cathodes of low effective work function was du to low-energy photons generated in the pre-breakdow currents, but that for clean metals the secondar emission was due to impact of positive ions; phot emission due to any high-energy photons generate in the ionization currents was negligible in compariso

537.525

6242. On the light intensities of small-type spectr lamps. I. H. TAKEYAMA, K. NISIMOTO AND MATUBAYASI. *J. Sci. Hiroshima Univ.*, **14**, 233– (*Sept.*, 1950).

Observations, with a photo-cell and oscillograp of fluctuations in light emission from low-pressu hot-cathode arc lamps, are described. J. D. CRAGG

537.525

6243. Note on a phenomenon concerning the termin voltage of a cadmium lamp. H. TAKEYAMA AN K. NISIMOTO. *J. Sci. Hiroshima Univ.*, **14**, 237– (*Sept.*, 1950).

Briefly describes certain oscillations observable c the terminal voltage waveform with particular lo pressure discharges. J. D. CRAG

537.525.5 : 621.314.653

6244. Behavior of the resistance ignitor in mercury. W. W. RIGROD. *J. Appl. Phys.*, **22**, 787–96 (*June*, 1951).

An empiric expression is derived for the probability of arc striking per unit time, per unit length of contact perimeter, for a resistance ignitor in a mercury-pool tube: $p' = k(E - E_0)^3/\rho^2$, where k and E_0 are constants, E is the "useful" electric field strength near the mercury surface, and ρ the resistivity of ignitor material at the junction with the mercury. From the foregoing, a formula is established for the probability of ignition per unit time, for the entire ignitor, in terms of the applied voltage v and ignitor "firing resistance" R. With this formula, whose two arbitrary constants can be determined by two sets of measurements, the firing voltage of any ignitor can be predicted under a wide variety of circuit conditions, provided R remains unchanged under these conditions. The probability formula was found to be consistent with a modification of a theory advanced by L. Tonks, whereby mercury surface distortion and rupture permit field emission at field strengths $<$ those effective for smooth surfaces. The modification attributes the reduction in ignitor firing voltage by ignitor current to its extremely localized ohmic heating of the mercury. This heating reduces the surface tension and roughens the mercury surface, thereby accelerating the process of surface rupture by the electric field. A.

537.525.72

6245. Measurement of the parameters of an electrodeless h.f. discharge by two probes. L. BIBERMAN AND B. PANIN. *J. Tech. Phys., USSR*, **21** (*No.* 1) 12–17 (1951) *In Russian.*

The discharge tube of 13 cm dia. was placed between two Cu foil electrodes of 60×60 cm area, so that the field was homogeneous. The measuring circuit contained a frequency meter and crystal detector. The frequency was 22·4 Mc/s; the discharge was produced in Hg vapour. The sondes were held at high constant potential, on which the h.f. component was superimposed by discharge; they were cylindrical and so mounted that the field along them as well as the flux linking with them was a minimum. Calculation shows that ions, owing to inertia, obtain energy 2 orders below thermal energy. Thus for ions a Maxwell distribution with temperature corresponding to gas temperature may be assumed, and tentatively assumed for electrons. The ionic current is less sensitive to voltage variations than the electronic current, which accounts for unequal voltage distribution on sondes. The more negative electrode takes the greater part of the external voltage. Sondes remain always negative with respect to plasma, and at high external voltages the more negative sonde carries only ionic current. Evaluation of results shows that electron temperature considerably exceeds the values observed in d.c. Hg-discharge at the same pressure. Calculated values correspond to 37 000–46 500°. B. F. KRAUS

537.527.5

6246. Excitation temperatures of hydrogen arcs. H. EDELS AND J. D. CRAGGS. *Proc. Phys. Soc., Lond. A*, **64**, 562–73 (*June*, 1951).

Measurements of the relative intensities of the first three Balmer series lines (H_α, H_β and H_γ) excited in low current (up to 10 A) d.c. arcs in hydrogen are described. The pressure range was from 1–2 atmospheres. The results after correction for self-absorption show that the populations of the appropriate excited states are not those given by a Boltzmann distribution, that is, the data obtained cannot be described in terms of a single excitation temperature. Possible causes of this effect are briefly considered. A.

537.527.5

6247. Balmer line widths in hydrogen arcs. H. EDELS AND J. D. CRAGGS. *Proc. Phys. Soc., Lond. A*, **64**, 574–82 (*June*, 1951).

The paper describes measurements of the widths of the Balmer lines H_α, H_β and H_γ in d.c. hydrogen arcs (1–2 atmospheres pressure), for currents up to 10 A. The results are used to deduce ion concentrations, and their bearing on the physical properties of the discharges is discussed. A.

537.528 : 621.3.015.51 : 621.315.61

6248. Formation of "bridges" in suspensions of conductors or semiconductors in dielectrics. II. L. G. GINDIN, L. M. MOROZ, I. N. PUTILOVA AND YA. I. FRENKEL. *J. Tech. Phys., USSR*, **21** (*No.* 2) 143–8 (1951) *In Russian.*

See Abstr. 3550 (1951) for part I. The behaviour of a 0·1% suspension of Al in petrol in strong electric fields was investigated. The process of bridge formation between the electrodes, which determines the final breakdown of the suspension, does not depend on shape, material or surface condition of the electrodes. Viscosity and specific weight of the dispersing medium, whilst not influencing the critical or breakdown voltage of the field, E_{crit}, determines the duration of the formation time, or rate of formation, of the bridges and also their "life" after removal of the field. E_{crit} depends on the dielectric constant of the dispersing medium and on the duration of the preliminary application of the field. The length of the obtainable bridges may be 3–4 cm, and even longer in more viscous media like vaseline oil. The measured resistances of 25 bridges varied between 150 and 18 000 Ω, and the initial resistance value increases during the lifetime of the bridge, and may reach several MΩ. Comparative values of E_{crit}: petrol ($\varepsilon = 1{\cdot}9$), 4 250; diethyl ether ($\varepsilon = 4{\cdot}5$), 4 000; chlorobenzene ($\varepsilon = 5{\cdot}94$), 2 250; nitrobenzene ($\varepsilon = 36{\cdot}5$), 1 750 V. B. F. KRAUS

537.529

6249. The mechanism of electric breakdown in solid dielectrics. W. FRANZ. *Z. angew. Phys.*, **2** (*No.* 2) 72–80 (1951) *In German.*

A review of modern theories of dielectric breakdown. E. RUSHTON

537.529 : 621.3.015.533 : 621.315.611

6250. Electrical breakdown over insulators in high vacuum. P. H. GLEICHAUF. *J. Appl. Phys.*, **22**, 766–71 (*June*, 1951).

The breakdown voltage of vacuum gaps depends on the electrode material, but when the gap is bridged by an insulator it is independent of the electrode material and varies with the kind of insulator. Some indication is found that the breakdown voltage increases with increasing surface resistivity of the

insulator, but no apparent correlation is found between breakdown voltage and dielectric constant, density or vapour pressure. It is found that a roughening of the intervening surface of the insulator in a region adjacent to the cathode increases the breakdown voltage. For electrode separations of 1 mm or greater the breakdown voltage does not increase linearly with the length of the insulator. Experiments were made in which one of the electrodes was separated from the insulator. It seems that the critical gradient at breakdown in the vacuum space between the cathode and the insulator, calculated for the case of plane electrodes from the ratio of dielectric constants, is not as large as would be required in gaps without insulators. These gradients are almost the same for copper as for stainless steel electrodes. The breakdown voltage over an insulator is raised when the edge of the insulator close to either electrode is rounded. When a layer of glass, thin compared with the separation of electrodes, is fused to the cathode, breakdowns occur at lower voltages than for an identical vacuum gap. A.

X-RAYS 537.531

537.531 : 548.733

6251. An X-ray micro-beam technique. I. Collimation. P. B. Hirsch and J. N. Kellar. *Proc. Phys. Soc., Lond. B*, **64**, 369–74 (*May*, 1951).

A technique is described which depends on the use of X-ray beams down to approximately 1 μ diameter, obtained by means of lead glass capillaries. The micro-beam precision camera incorporates collimator holders for aligning the capillaries, and enables simultaneous transmission and back-reflection photographs to be taken. The effect of the divergence of the X-ray beam on the photographs is considered, and a formula is derived for the mean value of the divergence at the specimen. The optimum collimating conditions are discussed in relation to maximum resolution and minimum exposure. The use of totally reflecting glass collimators is considered. An example is given of the application of the micro-beam technique to the study of cold-worked metals. It is found that, using a high intensity generator, single reflections can be obtained from crystals of diameter of the order of 2 μ in about 10 hours. A.

537.531 : 548.733

6252. An X-ray micro-beam technique. II. A high intensity X-ray generator. P. Gay, P. B. Hirsch, J. S. Thorp and J. N. Kellar. *Proc. Phys. Soc., Lond. B*, **64**, 374–86 (*May*, 1951).

A generator has been constructed which combines the use of small foci and a rotating anode. Improvements in target loading per unit area of about 50× compared with ordinary stationary target tubes have been obtained. Any width of focus between about 1 mm and 50 μ can be produced by means of an adjustable, biased electron gun. A detailed experimental investigation of the focusing properties of the high voltage gun has been made; the conditions for obtaining small foci and maximum current are derived. The magnitude of the negative bias is found to be the most important factor controlling the focusing action of the electron gun. The effect of bias on focal structure is discussed for several types of filament, and is explained on the basis of suppression of emission from different parts of the filaments. A.

537.531 : 615.849

6253. X-ray dosage. R. W. Pohl. *Naturwissenschaften*, **37** (*No.* 7) 147–50 (1951) *In German.*

The fundamentals of X-ray dosage, and its unit of measurement, are discussed. It is emphasized that the roentgen is a measure of energy absorbed in air. Energy absorbed in irradiated tissue (the true X-ray dose) is related to the air measurement through the stopping powers, compared with air, of the tissue materials. A "specific dose" or "mass dose," whose unit is, in effect, the "rep," is advocated.

D. V. Mabbs

537.531 : 771.534.5

Characteristics of some films for 20 million volt X-rays. *See Abstr.* 6669

537.531.85 : 539.166

6254. Accurate focusing of Compton electrons. B. S. Dzhelepov. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 3) 389–90 (1951) *In Russian.*

See Abstr. 3377 (1950). Monochromatic γ-rays from a point source strike a foil in a uniform magnetic field; each Compton electron is assumed to have initially the direction of the γ-ray producing it. An equation is given for the shape of the foil, in order that focusing in the normal plane containing the source shall be perfect. Electrons with a velocity component parallel to the field are also considered.

J. C. E. Jennings

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

6255. Harmonic resonance accelerator-microtron. J. Itoh and D. Kobayashi. *Sci. Pap. Osaka Univ.*, *No.* 12, 7 *pp.* (1949).

The theory of the microtron, in particular with respect to the resonance condition, phase stability, electron transit time and focusing, is discussed.

J. Hughes

537.533

6256. An experimental electron accelerator. R. D. Hill. *Proc. Roy. Soc. Vict.*, **60**, 81–92 (1950).

An electron cyclotron is described in which the relativity-increase of mass is compensated by modulating the magnetic field instead of the frequency of the r.f. field. It is shown that there is some advantage to be gained in the use of air-cored coils. The practical limits for these are not discussed. An experimental model was built using a 1 μsec pulse of 200 kW peak power from a 25 cm magnetron as the driving field, the repetition frequency being 100 c/s. On a d.c. magnetic field of 425 gauss was superimposed an alternating field of initial amplitude 270 gauss and frequency 430 kc/s, obtained from a condenser discharge into a pair of Helmholtz coils. A pair of

"skeleton" dees was used to avoid eddy currents and the dee-to-dee voltage was estimated as at least 3 000. [This would represent a transfer efficiency of power from magnetron to dees of well under ½%]. A filament source of electrons was used and X-rays obtained when the accelerated particles struck an internal target. X-rays of 200 keV and 500 keV respectively should have been expected from the target position, with and without the dynamic field. In fact, mean outputs of order 0·1 millicurie [which would correspond to about 10^{-9} amp peak or 10^{-13} amp mean] were obtained at 60 keV in each case. [This and the broad resonance curve obtained suggest that a simple cyclotron acceleration of electrons starting some distance from the filament is alone involved]. Extension of the system to very high energy is discussed. J. H. FREMLIN

537.533 : 621.385.032.21

6257. Transit-time phenomena in electron streams. II. The electron-ion plasma and beam fluctuations. D. K. C. MACDONALD. *Phil. Mag.*, **42**, 515–22 *May*, 1951).

Pt II, Abstr. 362 (1951). An analysis is now made of the noise in a travelling electron beam where the fluctuating interaction is included, as expressed by Poisson's law. The results are considered in relation to some practical valve problems. There is a short discussion of the characteristics of electron-ion and electron plasmas based on a lattice model.

L. S. GODDARD

537.533.72

6258. 3-Dimensional distribution of charged particles in an inhomogeneous magnetic field. Application to β-spectrography. J. LAFOUCRIÈRE. *C.R. Acad. Sci., Paris*, **232**, 1346–8 (*April* 2, 1951) *In French.*

The field is due to 2 equal and opposite poles with axial symmetry. The source is a point in the median plane between them. The theory of Abstr. 2506 and 4124 (1950) is extended to rays inclined to that plane. Rays of a family, which in the median plane describes a trochoid, are confined on the side of great r by a surface tangential to the median plane; whilst a family, which in the median plane is asymptotic to a stationary orbit, is confined by a surface intersecting the median plane at a finite angle. J. C. E. JENNINGS

537.533.72

6259. The electron optical theory of the deflection of an extensive electron optical picture by means of a crossed electrical deflection system. J. HIMPAN. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 405–22 (1951) *In German.*

A rigorous mathematical formulation of the problem, including the 3rd-order errors. Conditions for distortion-free deflection are given and the 6 3rd-order errors are classified, 3 giving rise to distortions of the picture and 3 to deformations of the spot. Expressions for the error constants are given. A. H. W. BECK

537.533.74

6260. Electron-electron scattering from 0·6 to 1·7 MeV. L. A. PAGE. Letter in *Phys. Rev.*, **81**, 1062–3 (*March* 15, 1951).

β-rays on atomic electrons. Shows good agreement with the Møller formula. W. J. SWIATECKI

537.533.74

6261. On an anomaly concerning the scattering of β-rays in matter. I. T. YUASA; **II.** T. YUASA AND P. RADVANYI. *C.R. Acad. Sci., Paris*, **232**, 1348–50 (*April* 2); 1417–19 (*April* 9, 1951) *In French.*

Cloud-chamber investigations have been made on the scattering of (1) P^{32} β-rays and In^{115m} internal-conversion electrons at a 0·3 mg cm^{-2} Al foil, and (2) P^{32} β-rays at a 1 mg cm^{-2} Au foil. It is claimed that the results show that as the mass of material between the source and scattering foil was increased (both by increasing the distance between source and scattering foil and by insertion of thin sheets of polystyrene), in (1) the % of tracks scattered through (*a*) $>5°$ and (*b*) $>10°$ decreased for P^{32}, whilst for In^{115m} it remained unchanged, and for (2) there was a decrease for (*a*) and (*b*). The decreases of angular scattering of the P^{32} β-rays are considered to be contrary to the known laws of electron scattering.

J. C. E. JENNINGS

537.533.74 : 539.166.83

6262. Scattering of secondary electrons produced by γ-rays in materials of various atomic numbers. G. J. HINE. Letter in *Phys. Rev.*, **82**, 755 (*June* 1, 1951).

537.533.8

6263. A comparison of theories of secondary emission. J. J. BROPHY. Letter in *Phys. Rev.*, **82**, 757 (*June* 1, 1951).

Results obtained from quantum mechanical and free electron treatments are found to be very similar. J. A. FRANKS

537.533.8 : 537.583

6264. On the secondary electron emission from the thoria coated cathode and the thin film deposited by evaporation from the cathode. T. ARIZUMI AND L. ESAKI. *J. Phys. Soc. Japan*, **6**, 113–18 (*March–April*, 1951).

The secondary emission was studied as a function of primary energy, emitter temperature and state of activity. For cold cathodes δ has a broad max. at ~1 kV, the value increasing slightly with activity (δ max. = 1·35, ϕ = 2·7 eV). The secondary yield increases slightly at high temperatures. Electron bombardment reduces the work function from 2·7 eV to 2·0 eV. Thin films evaporated on Ta were also studied. δ max. is reached at much lower voltages, ~400 V. By comparison with results for pure Th it is concluded that about 30% of the evaporated product at 1960°K is thoria. A. H. W. BECK

537.534.72

6265. A mass spectrometer. R. BONNE, R. MARGOLOFF AND J. BERNAUDAT. *Onde Elect.*, **31**, 109–21 (*March*, 1951) *In French.*

Various problems associated with the design of a mass spectrometer are discussed. An instrument built for the Atomic Energy Commission is described. This has a resolution of 1 in 220 and a mass range of 1 to 300. B. ROSE

537.534.72

6266. On a momentum-mass spectrograph. M. J. HIGATSBERGER. *Z. Naturforsch.*, **6a**, 151–4 (*March*, 1951) *In German.*

The path is calculated for a charged particle injected at an angle into uniform, parallel electric and

magnetic fields. It is shown how a two-fold resolution according to mass and momentum is obtained.

W. J. SWIATECKI

537.534.74

6267. Survey experiments on elastic scattering. J. W. BURKING AND B. T. WRIGHT. Letter in *Phys. Rev.*, **82**, 451 (*May* 1, 1951).

Angular distributions for 18·6 MeV protons on W, Pd, Ni, Al, and relative cross-sections at 78·7° of a number of elements are given [for method see Abstr. 1073 (1949)]. W. J. SWIATECKI

537.534.74 : 539.164.74

6268. Scattering of 20 MeV alpha-particles by helium. K. B. MATHER. Letter in *Phys. Rev.*, **82**, 126 (*April* 1, 1951).

The scattered particles were detected in radially disposed photographic emulsions, with defining slits for each angle. Differential cross-sections are given for 12 angles between 14° and 120° in C. of M. space, and are compared with Mott cross-sections.

T. G. PICKAVANCE

537.534.75 : 778.3

6269. Accurate measurement of the energy of heavy charged particles of small range by impregnation of photographic emulsions. H. FARAGGI. *Ann. Phys., Paris*, **6**, 325–400 (*March–April*, 1951) *In French.*

A critical survey establishes the impregnation technique as the most suitable for the study of particles of small range. Details are given of the photographic effects of various substances when used for impregnation and the methods for successfully introducing several elements into the emulsion are described. By impregnating the emulsion with Th nitrate and utilizing the known energy and range data for U and Po alpha-particles, the range in air of Th alpha-particles was found to be $2{\cdot}48 \pm 0{\cdot}03$ cm and their energy $3{\cdot}98 \pm 0{\cdot}04$ MeV. A technique is described, based on the partial eradication of the latent image, which enables the ranges of heavy particles emitted during a transmutation to be measured separately. A combination of this technique and impregnation has been used to establish that the energy released by the fission of Th^{232} by fast neutrons is 140 ± 10 MeV, and that the total range in air of the fragments emitted is $4{\cdot}1 \pm 0{\cdot}04$ cm. In about 1% of the transmutations a third particle of small energy is emitted. An experimental range-energy relationship has been obtained for low energy alpha particles by utilizing neutron reactions in Li^6, B^{10} and N^{14}. The stopping power of the emulsions for low energies has been found to be greater than the theoretical predictions. An empirical relation between the range of a low-energy alpha-particle and a Li nucleus of the same velocity is given. A. C. COATES

537.534.75 : 778.3

6270. Range-energy relation for protons and alpha-particles in photographic emulsions for nuclear research. J. ROTBLAT; J. CATALA AND W. M. GIBSON. *Nature, Lond.*, **167**, 550–2 (*April* 7, 1951).

The range-energy relation in nuclear research emulsions has been extended by Rotblat up to energies of 15 MeV for protons and 19 MeV for alpha-particles by a method similar to that previously described [Abstr. 5226 (1950)]. The photographic plate was exposed to protons and alpha-particles resulting from $d - p$ and $d - \alpha$ reactions in various gases in such a way that angles of emission from 20° to 160° could be recorded simultaneously. The energies of the various particles were determined by an extrapolation method involving the angle of emission of the particles, the energy of the deuteron beam and the previous range-energy calibration, but not involving the Q-values of the reactions employed. The range-energy relationships are given in graphical and tabular form and an accuracy of 0·5% is claimed. The results show good agreement with those of other workers for low energies, but for the higher energies the new calibration gives ranges which are 2–4% lower for a given energy. The measurements were made on Ilford C2 plates and conversion factors for several other types of plates are given. Batala and Gibson have determined the range-energy relation in Ilford C2 plates for protons of energy from 5 to 16·3 MeV and for alpha-particles of energy from 8 to 19 MeV by an exactly similar method, except that the energies of the particles were computed from a knowledge of the Q-values of the various reactions employed. The range-energy relationships obtained are in close agreement with those of Rotblat and an accuracy of 0·5 to 1% is claimed. A. C. COATES

537.534.75 : 778.3

6271. Thinning-down effect in nuclear photographic tracks. T.-F. HOANG. Letter in *Nature, Lond.*, **167**, 644–5 (*April* 21, 1951).

Tracks due to heavy nuclear particles show a thinning-down effect when the velocity of the particle slows down below a certain limit. The length of this thinning-down has been observed to be approximately a linear function of the atomic number, whereas previous theoretical calculations indicated a square law. A possible explanation is given. A. C. COATES

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 537.525.5

6272. A study on ion source of low voltage arc type. S. OZAKI. *Sci. Pap. Osaka Univ., No.* 10, 5 *pp.* (1949).

Gives characteristics (e.g. gas consumption, ion beam/arc current relation, etc.) for a hydrogen ion source, with cold cathode, operating at $\sim 10^{-3}$ to 10^{-4} mm Hg. Unanalysed beams of $\sim 200\ \mu A$ were obtained with ~ 40 mA discharge current.

J. D. CRAGGS

537.54

6273. The influence of the time lag fluctuations in Geiger counters on delayed coincidence measurements. A. LUNDBY. *Forsvarets. ForsknInst. Årb.* 2, 29–41 (1948–49).

537.54

6274. Investigation of proportional counters. V. A. TROFIMOVA. *J. Tech. Phys., USSR*, **20**, 1141–6 (*Sept.* 1950) *In Russian.*

Determination of the dependence of the coefficient of gas amplification on the point of incidence for

various gas-fillings of the counters. Cylindrical counters with Al and brass cathodes and W filament 0·1 mm thick were investigated, a Po-filled glass tube of 0·5 mm dia. serving as α-particle source inside the counters. It could be moved in a radial direction, to vary point of incidence, as well as axially inside the counter. For "background" measurements the Po tube was taken out of the counter. The measurements comprised determination of the counter impulses N/min under α-bombardment as function of the radio-technical amplification factor at a constant threshold V_n, i.e. $N = f(k_{\text{rad}})$. The counter fillings were methane, propylene, ethylene, A, air, methylal $(C_3H_6(OH)_2)A + C_2H_5OH$. In the last two cases, the dependence of N on point of incidence is very marked. An interpretation of the results is based on Veksler's (Doct. Diss.) application of Thomson's theory of negative-ion formation to proportional counters. B. F. KRAUS

537.542

6275. On the mechanism of the discharge process involving large pulses in pure vapour-filled counters. H. NEUERT. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 341–9 (1951) *In German.*

Describes the processes governing the formation of counter-tube impulses in the case of α-particles fired radially into the counter. Electron and positive ion collection are discussed, also space charge effects and the role of recombination processes in producing photo-ionizing radiations possibly responsible for discharge propagation. J. D. CRAGGS

537.542

6276. The use of the counter tube Tracerlab TGC3 and of the nucleometer RCL Chicago for the measurement of K radiation. J. GOVAERTS. *Bull. Soc. Roy. Sci. Liège*, **20**, 167–73 (*March*, 1951) *In French.*

A comparison of the efficiencies is made using the K radiation from Fe^{55}. J. HUGHES

537.542

6277. Time-delays in low-voltage halogen-quenched Geiger-Müller counters. W. R. LOOSEMORE AND J. SHARPE. Letter in *Nature, Lond.*, **167**, 600–1 (*April* 14, 1951). These were found to be $\sim 5{\cdot}3 \pm 2$ μsec. W. J. SWIATECKI

537.542

6278. An external cathode hard-glass Geiger-Müller tube. M. YASIN, R. AHMED AND P. S. GILL. Letter in *Nature, Lond.*, **167**, 647 (*April* 21, 1951).

Plateaux extending from 1 200 to more than 3 000 volts were obtained, with a slope less than 0·4 %/100 volts. The pulse amplitude decreases with counting rate, giving rise to an apparent increase of the threshold voltage with counting rate, and graphs are given of the effect. A deadtime of 3×10^{-4} sec was found. The use of a preamplifier before the scaler enabled a counting rate of more than 4 000 counts/min to be used. J. HUGHES

537.542

6279. Measurement of Geiger counter plateau slope. D. E. HULL. Note in *Rev. Sci. Instrum.*, **22**, 338 (*May*, 1951).

Demonstrates how the plateau characteristics of a Geiger counter depend, in some circumstances, on source position, etc. J. D. CRAGGS

537.542 : 535.37

6280. Data on fluorescent liquids for scintillation counters. H. KALLMAN AND M. FURST. *Nucleonics*, **8**, 32–9 (*March*, 1951).

The integrated intensities of light emitted from a large number of single solutes in organic solvents under gamma-ray irradiation, are tabulated. The measurements were made with a photomultiplier having a maximum response at 3 400 Å and the luminescent efficiencies are given relative to a standard anthracene crystal. L. R. SHEPHERD

537.542

6281. Addition of specified elements to liquid counters. S. A. COLGATE. Note in *Rev. Sci. Instrum.*, **22**, 346 (*May*, 1951).

Gives data on the quenching efficiencies of various substances (24 are listed) when added to diphenyl benzene in xylene and used as a liquid scintillation counter for γ-rays. J. D. CRAGGS

537.542

6282. A secondary-electron photon recorder. S. F. RODIONOV AND A. L. OSHEROVICH. *Dokl. Akad. Nauk, SSSR*, **74** (*No.* 3) 461–3 (1950) *In Russian.*

Gives performance details of a 15-stage secondary-emission amplifier at −183° and −76°C. E. P. GEORGE

537.542

6283. Line noise interference with particle counting. C. G. GOSS AND F. M. GLASS. *Nucleonics*, **8**, 66–9 (*Feb.*, 1951).

Transient bursts of oscillation on power supply lines can give rise to spurious counts during the recording of very small pulses with high gain amplifiers. The causes and methods of reducing such transients are discussed and a circuit is described which can be used to monitor line noise and give warning of the occurrence of these disturbances. L. R. SHEPHERD

537.542 : 621.318.572

6284. The cascaded binary counter with feedback. G. F. MONTGOMERY. *J. Appl. Phys.*, **22**, 780–2 (*June*, 1951).

The count of a cascade of binary pulse counters having any arrangement of feedback connections can be calculated. The calculation is simplified for two special connection patterns. For a particular count, one or the other of these patterns, or a modification of the two, requires a least number of connections. A.

537.542

6285. Effects of geometry on scattering distributions in the Wilson cloud chamber. A. V. CREWE AND A. E. LITHERLAND. *J. Sci. Instrum.*, **28**, 182–5 (*June*, 1951).

When a Wilson cloud chamber is used to study the scattering of charged particles, errors in the scattering distribution usually arise from the variation of the efficiency of detection with the scattering angle. A method is discussed whereby a correction can be

applied for any particular arrangement of scattering foils and counters. In the case of a scattering distribution which is Gaussian, or can be expressed as a sum of Gaussians, the correction is particularly easy, reducing to a simple numerical integration. A.

537.543 : 621.385.2

6286. Space-charge distribution, characteristic, and current fluctuations in 'double diodes.' R. FÜRTH. *Proc. Phys. Soc., Lond. B*, **64**, 404–12 (*May*, 1951).

The distribution of space charge and potential in thermionic tubes with two hot electrodes ("double diodes") is derived by the method of statistical mechanics for plane parallel electrodes, first for tubes in true thermodynamic equilibrium, and then, approximately, for tubes with applied external voltage or with electrodes at slightly different temperatures. The dependence of current on voltage in the first case (characteristic), and on temperature difference in the second case is calculated. Finally a general expression for the current fluctuations ("noise") in double diodes is given and discussed. The application of this formula to other types of conductors is also indicated. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

6287. A correction factor to Gray's theory of ionization. A. A. K. IBRAHIM. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 509–10 (*May*, 1951).

This results in a considerably improved agreement with experiments on Ce. W. J. SWIATECKI

537.565

6288. On Langevin's analyser for the study of mobilities of gaseous ions. E. MONTEL AND T.-T. OUANG. *C.R. Acad. Sci., Paris*, **232**, 1543–5 (*April* 23, 1951) *In French.*

See Abstr. 1816 (1950). The apparatus is described. Measurements quoted indicate that laminar flow occurs at the speeds considered. This is essential.

S. MICHAELSON

537.567

6289. De-ionization of Hg vapours at low pressures in a strong electric field. B. G. MENDELEV AND L. A. SVYATOEZERSKAYA. *J. Tech. Phys., USSR*, **21** (*No.* 1) 18–25 (1951) *In Russian.*

The back voltage was 9 000 V. Oscillographic investigation in an experimental tube with displaceable anode and sonde proved the known fact that back voltage is concentrated, or confined to, the layer of space charge (+) around the anode and has no influence elsewhere; the boundary of this region, however, moves in time from anode to cathode. This movement proceeds more rapidly the higher the inverse voltage applied. The rate of propagation of the layer boundary during time interval $60 < t < 400$ μsec is constant, of the order 10^4 cm/sec and proportional to back voltage. Some possible explanations of this phenomenon are presented.

B. F. KRAUS

537.58 : 621.385

6290. Considerations on the transformation of heat into electrical energy in thermionic phenomena. R. CHAMPEIX. *Vide*, **6**, 936–40 (*Jan.*, 1951) *In French.*

Experiments on a diode in which both cathode and anode could be heated and their temperatures measured with thermocouples are described. When both electrodes are at the same temperature no current flows through the valve. The correct expression for the contact potential, $V_c = \phi_2 - \phi_1 + kTe^{-1} \log A_1/A_2$ is deduced and it is shown that the correction term is equivalent to the Peltier E.M.F. The efficiency of the heat engine formed by the system of hot cathode-cold anode is calculated. Applications mentioned are a diode with anode and cathode temperatures identical and therefore zero current at zero voltage. Further, it has been proved that when the cathode is oxide-coated the anode must be at the core temperature to obtain zero current and not at the (lower) coating temperature. The author interprets this as indicating that the emission arises at the core and not in the coating. A. H. W. BECK (R)

537.581

6291. Thermionic emission of semi-conductors. T. HIBI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2** 157–66 (*Feb.*, 1950).

Using a new formula for thermionic emission obtained from the value of Fermi-surface introduced by Hirone and Miyahara, various numerical calculations were made, mainly on the experimental results of BaO by Nisibori, Kawamura and Hirano. Then, comparing with experimental results, the change of the work function of oxide cathodes with degree of activation and temperature was interpreted with this theory as a trial. The similarity between electric conductivity and thermionic emission was also considered. A.

537.583

6292. Pulsed emission from the BaO–SrO–CaO system. L. E. GREY. Letter in *Nature, Lond.*, **167**, 522 (*March* 31, 1951).

The max. pulsed emission at 1 000°K from triple carbonate mixtures is $\sim 8{\cdot}0$ A/cm^2 at the composition BaO : SrO : CaO = 47 : 43 : 10. The emission falls off sharply for variations of composition $> 2\%$ [for BaO : SrO see Abstr. 6589 (1950)]. A. H. W. BECK

537.583

6293. Emission decay in oxide-coated cathode due to gaseous adsorption. S. DEB. Letter in *J. Sci. Industr. Res.*, **10B**, 77–8 (*March*, 1951).

Expressions are developed for the decay of emission from an oxide cathode when both mobile and immobile layers of poisoning gas are adsorbed on the surface. For the case of mobile adsorption and for low partial pressure of the adsorbate, $i = i_\infty(1 - De)^{-1} - Bi_\infty t$, $D = (i_0 - i_\infty)/i_0$. Numerical values lead to a decay time to 1/eth of the initial value of $\sim 10^{-3}$ sec. This is of the order of the decay time in pulsed emission measurements. A. H. W. BECK

537.583

6294. On the Schottky effect of the oxide coated cathode. T. ARIZUMI AND S. NARITA. *J. Phys. Soc. Japan*, **6**, 118–21 (*March–April*, 1951).

The slopes of Schottky lines for oxide cathodes are

much greater than is indicated by conventional theory and increase with diminution in thermionic activity. Patch theory is used to explain the phenomena. The results give rise to differences in ϕ of the order $0{\cdot}2-0{\cdot}4$eV and patch dimensions of the order $10^{-3}-10^{-4}$ cm. As activity increases both magnitudes diminish. A. H. W. BECK

COSMIC RAYS 537.591

537.591

6295. Cosmic rays. L. LEPRINCE-RINGUET. *London, Constable and Co. Ltd.; New York, Prentice-Hall* (1950) 290 *pp.*

This (English) edition is based on the French edition of 1945, and although appropriate matter has been added, much of the emphasis of the subject at that time remains. This is a semi-popular book, in which, in addition to the usual topics of cosmic rays, a summary of the main features of atomic particle physics (concepts of corpuscular physics) and of relativistic physics are included. The treatment is nowhere exhaustive; for example, the diffusion equations of the electron-photon cascade are not derived nor are actual numerical results on cascades quoted. The most notable feature is the treatment of the background of the subject, many photographs of laboratories and apparatus are given, and the staffs of the major cosmic-ray laboratories are shortly reviewed. Numerous well-chosen examples of cloud chamber and emulsion photographs are also given.

J. G. WILSON

537.591.1

6296. Occurrence of stripped nuclei of neon in primary cosmic rays. M. N. SAHA. Letter in *Nature, Lond.*, **167**, 476–7 (*March* 24, 1951).

The complete absence of spectrographic evidence of the existence of Ne in the sun or in other main sequence stars, together with its identification in the gases ejected from the novae and in certain *B*- and *A*-stars, is of interest in view of the presence of Ne nuclei in the primary cosmic-ray beam. J. G. WILSON

537.591.1

6297. Decay of V-particles. R. ARMENTEROS, K. H. BARKER, C. C. BUTLER, A. CACHON AND A. H. CHAPMAN. *Nature, Lond.*, **167**, 501–3 (*March* 31, 1951).

Further material concerning the unstable V-particles, observed by Rochester and Butler [Abstr. 1071 (1948)] and by Anderson and others [Abstr. 6600 (1950)] has been collected at Pic-du-Midi (2 867 m altitude), which bears mainly on the decay of a neutral particle giving rise to two (oppositely) charged particles. Thirty-six such events have been observed, and it is shown that not more than 10% can be attributed to known processes. The positive products of decay are on average of higher momentum than the negative; some are identified as protons and a few are certainly lighter than protons. Some negative products are (μ or π) mesons, while none are identified as of protonic mass. In so far as the results of Anderson suggest that the decay is into two particles only, decay schemes involving two different neutral V particles are required, viz.: $V^0 \rightarrow p^+ + \pi^-$, $V^0 \rightarrow \pi^+ + \pi^-$, and the V particles are then of mass $\sim 2\,250\, m_0$ and $\sim 1\,000\, m_0$ respectively. Observations of the decay of charged V particles are less frequent (~ 6), and do not allow comparable deductions at this stage. J. G. WILSON

537.591.1

6298. Evidence of long-range secondary electrons accompanying cosmic rays in a proportional counter. S. D. CHATTERJEE. Letter in *Phys. Rev.*, **82**, 114–15 (*April* 1, 1951).

Long-range secondary electrons from cosmic-ray particles are studied by directing the beam of a counter telescope through the inactive region outside a grid cathode of a proportional counter.

J. G. WILSON

537.591.1

6299. Scintillation spectrum from cosmic rays at 30 000 feet. L. REIFFEL, C. A. STONE AND F. G. REST. Letter in *Phys. Rev.*, **82**, 121–2 (*April* 1, 1951).

The cosmic-ray pulse distribution in anthracene has been measured at 50°N latitude and 30 000 ft altitude, and compared with a Co^{60} calibration. The main response is due to electrons, but a considerable number of low-energy pulses is attributed to soft gamma-rays. J. G. WILSON

537.591.1

6300. A cloud-chamber study of the new unstable particles. H. S. BRIDGE AND M. ANNIS. Letter in *Phys. Rev.*, **82**, 445 (*May* 1, 1951).

Ten examples of V-particle decay (4, V^0 decay, 4 charged V decay, 2 uncertain) have been obtained in a multiplate chamber operated at depth 700 g cm^{-2}. In two cases of V^0 decay, it is deduced from ionization, range and scattering that one product particle is a meson. J. G. WILSON

537.591.1

6301. Ratio of negative to positive π-mesons in the stratosphere. W. F. FRY. Letter in *Phys. Rev.*, **82**, 747 (*June* 1, 1951).

The σ-meson stars at 60 000 ft are separated into μ- and π-meson events. Comparison with π–μ decays gives the ratio $3{\cdot}2 \pm 0{\cdot}7$ for π^-/π^+. E. P. GEORGE

537.591.1 : 537.542

6302. Scintillation counting of cosmic-ray particles. E. P. NEY AND D. M. THON. Letter in *Phys. Rev.*, **81**, 1068–9 (*March* 15, 1951).

The pulse height distribution of a pyrene in xylene scintillator, in a glass envelope painted with MgO outside, and used in coincidence with a threefold Geiger telescope, is measured and discussed. J. G. WILSON

537.591.1 : 537.542

6303. A scintillation counter measurement of heavy nuclei. E. P. NEY AND D. M. THON. Letter in *Phys. Rev.*, **81**, 1069–70 (*March* 15, 1951).

A scintillation counter unit (see preceding Abstr.) was flown to a depth of residual atmosphere 10 gm cm^{-2} for more than 5 hr, during which 30 000 pulses were recorded. The Z distribution of particles was deduced ignoring variations of velocity. While

the proton counting rate was constant through the flight there was some evidence of time variation of heavy particle flux. J. G. WILSON

537.591.15

6304. Angular distribution of photons in showers in lead. J. W. ROSE. Letter in *Phys. Rev.*, **82,** 747 (*June* 1, 1951).

This was measured by the activity produced in Cu-foil probes, using the 322 MeV X-ray beam of the Berkeley synchrotron. The results are compared with theory. E. P. GEORGE

537.591.5

6305. Directional measurements of the diurnal variation of cosmic ray intensity. H. ELLIOT AND D. W. N. DOLBEAR. *J. Atmos. Terr. Phys.*, **1** (*No.* 4) 205–14 (1951).

The results of former measurements of the solar daily variation in cosmic-ray intensity in the north and south directions have been confirmed by new data from shielded and unshielded recorders. The interpretation that the difference between the variations for the two directions is due to a non-isotropic distribution of the primary cosmic rays is strongly supported by measurements in the east and west directions. This lack of complete isotropy is discussed in relation to the solar streams which cause geomagnetic disturbances and which are here assumed to be polarized in a solar magnetic field. Good agreement is obtained between the observed effect and that calculated on this basis assuming a solar equatorial field strength of 8 gauss. It is shown that geomagnetic disturbances have a pronounced effect on the solar daily variation and on the south minus north difference. A small variation with sidereal time is shown to exist in the Manchester data and this is confirmed by an analysis of ionization chamber data from Huancayo, Christchurch and Cheltenham. The sidereal daily variation thus found has an amplitude of about 0·02% with a time of maximum at about 0500 hr. This is opposite in phase to the variation expected on the basis of the Compton–Getting effect and therefore a galactic origin for the primary cosmic rays is indicated. A.

537.591.5

6306. Seasonal and diurnal variations in cosmic ray intensity. D. W. N. DOLBEAR AND H. ELLIOT. *J. Atmos. Terr. Phys.*, **1** (*No.* 4) 215–22 (1951).

The seasonal variation in cosmic-ray intensity has been measured with two independent Geiger–Müller counter sets shielded with 35 cm of lead. It is shown that the variation is due to atmospheric temperature and pressure changes and can be completely explained only with the aid of Duperier's positive temperature effect. In addition it appears that the diurnal variation may partly be accounted for by the same mechanism. A.

537.591.5

6307. The intensity of the total and of the hard component of the cosmic radiation as a function of altitude at geomagnetic latitudes of 28°N and 55°N. M. VIDALE AND M. SCHEIN. Letter in *Phys. Rev.*, **81,** 1065–6 (*March* 15, 1951).

A counter system recording total vertical intensity and intensity traversing 12 cm Pb was flown to ~90 000′ in geomagnetic latitudes 28°N and 55°N. The hard component shows a maximum intensity in both latitudes, and the depth of atmosphere and increase of intensity to maximum at each latitude is measured. J. G. WILSON

537.591.5

6308. The interpretation of radiosonde data in relation to cosmic-ray intensity variation. R. H. KAY. Letter in *Proc. Phys. Soc., Lond. B,* **64,** 359–60 (*April*, 1951).

Possible errors in radiosonde data on which the heights of pressure levels, $p < 300$ mb, are established for use in cosmic-ray pressure and temperature correlations, are discussed, with particular reference to insolation. Among conclusions are: (i) that the apparent diurnal changes of isobaric height are suspect, but (ii) correlation of annual variation in the monthly mean value of the height of the 100 mb level with ground temperature is fully justified. J. G. WILSON

537.591.5 : 523.746

6309. The sun's activity and cosmic rays. E. G. v. ROKA. *Z. Naturforsch.*, **6a,** 117–22 (*March*, 1951) *In German.*

The correlation between sunspot number and cosmic radiation was investigated. The 27-day variation of cosmic radiation lags with respect to that of sunspot number with a phase-difference of 4–6 days. A good negative correlation exists between the two variations. The 27-day period of the cosmic radiation cannot be accounted for in terms of a solar component of c.r. E. P. GEORGE

537.591.8

6310. Transition effects of star-producing cosmic radiation in lead. E. SCHOPPER, K. H. HÖCKER AND G. KUHN. Letter in *Phys. Rev.*, **82,** 444 (*May* 1, 1951).

Kodak NT4 plates were exposed at 3 000 m horizontally at various depths up to 22 cm in a lead tower, and the relative intensity of radiation producing stars of at least two branches, one more than 70 μ long, determined. Results show a clear maximum under 1·2 cm Pb which is too large to be attributed to photon-initiated stars, and a marked secondary maximum in plates exposed close to the bottom of the lead tower. J. G. WILSON

537.591.8

6311. Secondary nucleons in lead. E. SCHOPPER, K. H. HÖCKER AND G. KUHN. Letter in *Phys. Rev.*, **82,** 445 (*May* 1, 1951).

Neutron-induced single proton tracks, which begin and end in the emulsion of Kodak NT4 plates exposed at various depths in Pb at 3 000 m altitude, increase by a fraction 2·5 up to a depth of about 12 cm Pb. J. G. WILSON

MAGNETISM 538

538.1 : 538.22

6312. Large negative molecular fields; various mechanisms of the transition between antiferromagnetism and Weiss paramagnetism. G. FOËX. *J. Phys. Radium,* **12,** 153–60 (*March*, 1951) *In French.*

A discussion of various substances having "anomalous" magnetic properties: (1) γFe, Fe_2O_3,

Fe_2O_3 . MgO and Pt, with large values of the Curie constant and a large negative Curie temperature Δ; (2) $FeCl_3$ and V_2O_3; (3) solid solutions of diamagnetic metals in Pd [Abstr. 3269, 4218 (1950)]; (4) compounds of Mn (e.g. MnO, MnS) for which Δ is large although the Mn–Mn distance is large (super-exchange). E. P. WOHLFARTH

538.1 : 538.22

6313. Recent developments in the theory of antiferromagnetism. J. H. VAN VLECK. *J. Phys. Radium*, **12**, 262–74 (*March*, 1951).

An extensive review, dealing with Néel's treatment, its modification by Anderson [Abstr. 481 (1951)] for a f.c.c. lattice, the relation between the susceptibility at 0°K and at the transition point (and the deviations of their ratio from the "classical" value 2/3), the bearing of recent neutron diffraction experiments, and Anderson's quantum mechanical treatment of super-exchange [Abstr. 8114 (1950)] slightly modified by the author. E. P. WOHLFARTH

538.1 : 538.22

6314. Magnetic viscosity. L. NÉEL. *J. Phys. Radium*, **12**, 339–51 (*March*, 1951) *In French.*

Discusses separately reversible and irreversible magnetic viscosity phenomena. For the former a new theoretical treatment is given. A fictitious time-dependent field is imagined to bring about a stabilization in direction of the spontaneous magnetization; it is proposed that the stabilization process is linked to a process of diffusion in the interior of the ferromagnetic and to the constraint of the magneto-crystalline coupling mechanism. Irreversible viscosity is briefly described, and the author's theoretical treatment, based on the effects of thermal fluctuations, is reviewed [Abstr. 4211 (1950)]. E. P. WOHLFARTH

538.1 : 538.22 : 538.55

6315. Ferromagnetic resonance. C. KITTEL. *J. Phys. Radium*, **12**, 291–302 (*March*, 1951).

A comprehensive review, dealing with theoretical treatments of the resonance phenomenon in specimens of different shapes, the difference between the two g-values, the "anti-resonance" point (e.g. in Heusler alloys) and the treatment of line width. Recent experimental results are discussed, including those on g-values and line widths in Ni and supermalloy at high temperatures [Abstr. 7361 (1950)], resonance phenomena in magnetite [Abstr. 6648 (1950)] and nickel ferrite [Abstr. 1929 (1951)]. The frequency-dependence of initial permeability, especially in ferrites, is discussed theoretically, and experimental results are given in support. E. P. WOHLFARTH

538.1 : 538.221

6316. The origin of intermittent activation in ferromagnetics. R. FORRER. *C.R. Acad. Sci., Paris*, **232**, 1746–8 (*May* 7, 1951) *In French.*

Further theoretical discussion of the previously introduced concept [Abstr. 5943, 6627 (1950)]. E. P. WOHLFARTH

538.1 : 538.54/.55

6317. Dynamics of the Bloch wall and high frequency permeability. R. BECKER. *J. Phys. Radium*, **12**, 332–8 (*March*, 1951) *In French.*

A review, mainly of the author's work, dealing with the statics of the Bloch wall, its movement in an alternating magnetic field and the frequency-dependence of initial susceptibility. The expression for $\mu_0(\omega)$, the complex permeability, contains two parameters, ω_0 and ω_1, depending on the effective mass of the wall, which is calculated in terms of known quantities, and the frictional resistance to wall movement due to eddy currents. The influence of the skin effect is also discussed. E. P. WOHLFARTH

538.1 : 548.0 : 530.145

6318. The quantum theory of magnetic anisotropy. S. V. TYABLIKOV. *J. Exp. Theor. Phys., USSR*, **20**, 661–8 (*July*, 1950) *In Russian.*

The magnetic anisotropy of crystals with a single principal axis is treated as a consequence of the anisotropy of the interactions between the electrons in incomplete shells. On the basis of the Heitler–London model the magnetization of a single crystal is calculated along and parallel to the principal axis. D. SHOENBERG

538.113

6319. Position of the levels of hyperfine structure in a magnetic field. A. S. KARAMYAN AND K. A. TER-MARTIROSYAN. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 6) 827–9 (1951) *In Russian.*

The calculation is briefly outlined and the energy levels and their derivatives with respect to the magnetic field are given graphically as a function of the field for a nucleus of spin 3 in a $P_{3/2}$ electronic structure. D. H. WHIFFEN

538.114

6320. Theory of galvanomagnetic effects in ferromagnetics. A. G. SAMOĬLOVICH AND V. L. KONKOV. *J. Exp. Theor. Phys., USSR*, **20**, 783–6 (*Sept.*, 1950) *In Russian.*

Galvanomagnetic effects in ferromagnetics are determined by magnetization, and not by induction, in this agreeing with magneto-optical phenomena. Rudnitskii [*J. Exp. Theor. Phys., USSR*, **10**, 774 (1940)] explained Hall effect in ferromagnetics by the accelerating effect of spin-orbital force on the d-electrons. His calculations were semi-classical, but it is shown that they may be obtained by strict quantum-mechanical treatment. The translation of the electron in the crystal lattice is described by a suitable wave-function, and a wave-packet of such functions formed. An external magnetic field is considered, to simulate a spontaneously magnetized domain. The usual Hamilton operator for spin-orbital interaction of the d-electrons has to be subjected to a gradient transformation, as otherwise it would not satisfy the initial conditions. Spin-orbital interaction of d-electrons with atomic residue produces the same variation of distribution function as a magnetic field of magnitude M (magnetization of d-electrons). Rudnitskii assumed vanishing of wave-function at the centre of atomic residue (this being a property of the d-state) and its being constant everywhere else in the atomic polyhedral. His theory, whilst possibly correct for d-electrons, cannot explain Hall effect. But one of the authors proved that s-electrons under the influence of d-electrons may very well produce the Hall effect, and also the Faraday effect in ferromagnetics. The rotation of the plane of polarization is also due to s-electrons and is $\propto$ magnetization of the d-electrons. B. F. KRAUS

538.114

6321. Theory of the coercive force. K. B. VLASOV. *J. Tech. Phys., USSR*, **20**, 1098–101 (*Sept.*, 1950) *In Russian.*

After a discussion of Kondorskii's "stress" and "inclusion" theories and Kersten's "inclusion" theory, an alternative theory is presented for alloys representing single-phase solid solutions of ferromagnetic or non-ferromagnetic components, where the constants characterizing the ferromagnetic state (anisotropy constant K, saturation magnetostriction λ_s and Curie point θ) depend on the concentration α of the components of the alloy. As the density of the free surface energy of the boundary layers between the domains (boundary energy) γ is a function of K, λ_s and the density of the exchange energy NA, it will also be a function of the concentration α and it may therefore be expected that the critical field H_0 (on which the value of the coercive force depends) and the permeability will be determined by the volume concentration distribution, or non-uniformity of the ferromagnetic in alloys free of inclusions or with macroscopic inclusions. Introducing into Kondorskii's theory of the critical field the heuristic motion of a "wavelength" l which characterizes the dispersion of the inhomogeneities of the concentration, and assuming that the dependence of α on x has the character of a broken line, Kondorskii's formula for the critical field H_0 takes the form

$$H_0 = 4\Delta\alpha/I_s(h_1 - h_2)$$
$$\left(b\partial K/\partial\alpha + 3/2\sigma\partial\lambda_s/\partial\alpha + \frac{bK + 3/2\lambda_s\sigma}{\theta}\frac{\partial\theta}{\partial\alpha}\right)p$$

(I_s is saturation magnetization, h_1, h_2 cosines of angles between directions of magnetic field and vectors of spontaneous magnetization in two neighbouring domains). This formula is then tested on experimental material obtained on alloys and pure ferromagnetics and compared with other existing theories, and estimates of the amplitude of the concentration oscillation are given. B. F. KRAUS

538.22

6322. Magnetic domain patterns. R. M. BOZORTH. *J. Phys. Radium*, **12**, 308–21 (*March*, 1951).

Previous work, especially that by Williams, Shockley and the author, is briefly reviewed. More recent experiments on the following substances are described: (1) A 60% Co–Ni crystal, for which the directions of easy magnetization are the [111] axes; (2) a single crystal of Co; (3) polycrystalline Fe–Si sheets, in which it is shown that domain boundaries sometimes cross grain boundaries; (4) Alnico V, with different methods of heat treatment in a magnetic field.

E. P. WOHLFARTH

538.22

6323. Elementary domains in a single crystal of cobalt. L. F. BATES. *J. Phys. Radium*, **12**, 322–4 (*March*, 1951) *In French.*

Shows powder patterns with and without an applied magnetic field. E. P. WOHLFARTH

538.22

6324. Experiments on a specimen with large domains. K. H. STEWART. *J. Phys. Radium*, **12**, 325–31 (*March*, 1951).

Describes experiments on a single crystal picture frame 3% Fe–Si specimen, whose hysteresis curve consists of a single large discontinuity, which is investigated in detail and discussed on the basis of theoretical ideas regarding domain boundary movements. E. P. WOHLFARTH

538.2

6325. Irreversible [magnetic] viscosity in weak fields. J. C. BARBIER. *J. Phys. Radium*, **12**, 352–4 (*March* 1951) *In French.*

Experimental evidence is given in support of Néel's theoretical treatment [Abstr. 4211, 5953–4 (1950)]. E. P. WOHLFARTH

538.2

6326. de Haas–van Alphen effect in aluminium and antimony. D. SHOENBERG. Letter in *Nature, London*, **167**, 647 (*April* 21, 1951).

538.2

6327. Magnetic study of some hydrates of boron compounds. M. PRASAD, C. R. KANEKAR AND L. S. KAMAT. *J. Chem. Phys.*, **19**, 686–9 (*June*, 1951).

See Abstr. 1069 (1950). Boron is known to form several hydrated compounds. The polyborates are particularly interesting, since they can be dehydrated stepwise at suitable temperatures, and several intermediate hydrates can thus be prepared. The present paper deals with the study of the susceptibilities of the hydrated and anhydrous compounds containing boron and the examination of the applicability of the additivity law to hydrates.

538.22 : 536.4

6328. Ferromagnetic anomaly in the thermal expansion of ferrites. L. WEIL. *J. Phys. Radium*, **12**, 260– (*March*, 1951) *In French.*

A summary of work already reported [Abstr. 869 (1950)]. E. P. WOHLFARTH

538.22 : 538.61

6329. A note on the ferromagnetic Faraday effect at centimetre wavelengths. F. F. ROBERTS. *J. Phys. Radium*, **12**, 305–7 (*March*, 1951).

An account of work on the rotation, θ, of the plane of polarization of a plane polarized wave with magnetic field parallel to the propagation direction. The experiments were carried out on several mixed Mg–Al ferrites, using a wavelength of about 3 cm and fields up to about 2 000 oersted. A simple theoretical treatment is partially confirmed by the experiments, in that θ is independent of H and proportional to the saturation magnetization when $H > 4\pi I_s$. E. P. WOHLFARTH

538.22 : 550.3

6330. Magnetic properties of baked clays and rocks. E. THELLIER. *J. Phys. Radium*, **12**, 205–18 (*March* 1951) *In French.*

An extensive review, dealing with the temperature and field dependence of the susceptibility of substances containing a small amount of a ferromagnetic, the remanent isothermal magnetization (hysteresis properties), and the phenomenon of thermoremanent magnetization. The importance of the investigations in geomagnetism is stressed. Recent theoretical work by Néel is considered [*Ann. Géophys.*, **5**, 99 (1949)]. E. P. WOHLFARTH

538.221

6331. Experimental evidence in the problems of antiferromagnetism. H. BIZETTE. *J. Phys. Radium*, **12**, 161–9 (*March*, 1951) *In French.*

A discussion of the relation between anisotropy of susceptibility and the directions of spontaneous antiferromagnetism for some simple substances ($FeCO_3$, MnF_2, MnO and MnO_2); the effect of superexchange; the effects of decreasing the magnetic ion content (e.g. in MnO–MgO); and the factors influencing the magnitude of the transition temperature. Thermal, electrical and optical properties are also discussed.

E. P. WOHLFARTH

538.221

6332. Antiferromagnetism of nickel and cobalt oxides. F. TROMBE. *J. Phys. Radium*, **12**, 170–1 (*March*, 1951) *In French.*

The transformation temperature of NiO is 647°K and that of CoO 292°K; the temperature variation of susceptibility is shown and the field dependence discussed. E. P. WOHLFARTH

538.221

6333. Magnetic properties of rhombohedral ferric oxide, α Fe_2O_3. R. CHEVALLIER. *J. Phys. Radium*, **12**, 172–88 (*March*, 1951) *In French.*

An extensive review. Mention is made of the superposition of paramagnetic and ferromagnetic behaviour of the oxide below 675°C; the properties in high fields and their dependence on history and methods of preparation; the properties in medium fields, particularly the pronounced hysteresis; the anisotropy of single crystals; and the dependence of the magnetic properties of small powder grains on grain size. E. P. WOHLFARTH

538.221

6334. Properties of non-metallic ferromagnetic compounds. A. MICHEL, G. CHAUDRON AND J. BÉNARD. *J. Phys. Radium*, **12**, 189–201 (*March*, 1951) *In French.*

An extensive review. Discussion of various oxides, nitrides and carbides of Fe, ferrites, carbides and nitrides of Ni, carbides of Co, and of Cr oxide and telluride. E. P. WOHLFARTH

538.221

6335. Ferromagnetic compounds of manganese with perovskite structure. J. H. VAN SANTEN AND G. H. JONKER. *J. Phys. Radium*, **12**, 202–4 (*March*, 1951) *In French.*

An account of the crystal structure and magnetic properties of substances having the general composition $La^{3+}Mn^{3+}O_3^{2-}$. $Me^{2+}Mn^{4+}O_3^{2-}$, where Me = Ca, Sr, Ba, Pb, Cd [Abstr. 5947 (1950)].

E. P. WOHLFARTH

538.221

6336. Ferromagnetism of metallic dysprosium. F. TROMBE. *J. Phys. Radium*, **12**, 222 (*March*, 1951) *In French.*

Experiments on different specimens fix the Curie point at 105°K and a second transformation point at 75°K. The temperature and field dependence of susceptibility is shown. E. P. WOHLFARTH

538.221

6337. Transformation points of the compounds MnAs and MnBi in relation to a possible mechanism of antiferromagnetism. C. GUILLAUD. *J. Phys. Radium*, **12**, 223–7 (*March*, 1951) *In French.*

Magnetic, thermal, electrical and structural measurements are reported and the results discussed theoretically. E. P. WOHLFARTH

538.221

6338. Magnetic properties of ferrites. J. L. SNOËK. *J. Phys. Radium*, **12**, 228–38 (*March*, 1951) *In French.*

A review, dealing with the historical background, methods of preparation and crystallography, and magnetic properties incl. initial permeability and results of high frequency resonance investigations.

E. P. WOHLFARTH

538.221

6339. Magnetic properties of ferrites. C. GUILLAUD. *J. Phys. Radium*, **12**, 239–48 (*March*, 1951) *In French.*

A summary of the author's experimental investigations of the ferromagnetic properties of simple and mixed ferrites and a discussion of the results [Abstr. 8862 (1950)]. E. P. WOHLFARTH

538.221

6340. Spontaneous magnetization of ferrites. R. PAUTHENET AND L. BOCHIROL. *J. Phys. Radium*, **12**, 249–51 (*March*, 1951) *In French.*

Experimental investigations are reported of the dependence of the absolute saturation magnetization of Cu and Mg ferrites on the quenching temperature of preparation. The temperature dependence of spontaneous magnetization was measured for Fe, Co and Ni ferrites. The results are discussed on the basis of Néel's theory. E. P. WOHLFARTH

538.221

6341. Paramagnetism of iron, cobalt and nickel ferrites. M. FALLOT AND P. MARONI. *J. Phys. Radium*, **12**, 256–7 (*March*, 1951) *In French.*

Reports precise measurements, up to 1 200°C, of the molar susceptibility, and discusses the applicability of Néel's formula $1/\chi_M = T/C + 1/\chi_0 - \sigma/(T - \theta)$. Values of the parameters C, χ_0, σ and θ are deduced; the value of C is $> C'$, the classical Curie constant calculated from the saturation moments of the ions with the assumption of a constant molecular field coefficient. E. P. WOHLFARTH

538.221

6342. Influence of thermal expansion on the value of the Curie constant of ferrites. L. NÉEL. *J. Phys. Radium*, **12**, 258–9 (*March*, 1951) *In French.*

See preceding Abstr. The difference between the parameter C in the author's formula for the paramagnetic susceptibility of ferrites and the classical Curie constant C' is interpreted by invoking a temperature variation of the molecular field coefficient due to thermal expansion. E. P. WOHLFARTH

538.221

6343. The ferromagnetism of the alloy FeB_2. A. J. P. MEYER AND P. TAGLANG. *C.R. Acad. Sci., Paris*, **232**, 1545–6 (*April* 23, 1951) *In French.*

The Curie point was fixed at 643°C and a temperature of magnetic isotropy at 468°C. The saturation

moment was found to be 169·3, corresponding to $2 \cdot 24 \mu_B$. The substance has a hexagonal structure and exhibits pronounced magnetic hardness.

E. P. WOHLFARTH

538.221

6344. Temperature dependence of the coercive force in monocrystals of transformer steel. K. B. VLASOV AND YA. S. SHUR. *J. Tech. Phys., USSR*, **21** (*No.* 1) 39–50 (1951) *In Russian.*

Results of measurements of the temperature relation on monocrystalline disks of transformer steel are presented. The temperature relation is found to depend on the crystallographic direction along which the measurements are carried out. The experimental relationships found are analysed on the basis of the technical magnetization curve. E.R.A.

538.221

6345. Ferromagnetism in the manganese-indium system. W. V. GOEDDEL AND D. M. YOST. Letter in *Phys. Rev.*, **82,** 555 (*May* 15, 1951).

The intensity of magnetization increases regularly in alloys containing from 3 up to about 50 weight per cent of Mn, and then dies out completely. Ferromagnetism is attributed to a single phase, the compound Mn_2In. G. F. HODSMAN

538.221

6346. On antiferromagnetism in a single crystal. N. J. POULIS, J. VAN DEN HANDEL, J. UBBINK, J. A. POULIS AND C. J. GORTER. Letter in *Phys. Rev.*, **82,** 552 (*May* 15, 1951).

Results are given for $CuCl_2 \cdot 2H_2O$. Magnetic moment as a function of external magnetic field, nuclear magnetic resonance of the protons and electronic magnetic resonance of the Cu ions have been studied. G. F. HODSMAN

538.221

6347. Theory of antiferromagnetic resonance. C. KITTEL. Letter in *Phys. Rev.*, **82,** 565 (*May* 15, 1951).

A classical calculation is made of the freqs. associated with magnetic dipole transitions, using as model two oppositely directed sublattices of magnetization. G. F. HODSMAN

538.221 : 536.48

6348. Some remarks on antiferromagnetism at low temperatures. C. J. GORTER. *J. Phys. Radium*, **12,** 275–8 (*March*, 1951) *In French.*

Reports experiments on various salts, $CrK(SO_4)_2 \cdot 12H_2O$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $Mn(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $CuK_2(SO_4)_2 \cdot 6H_2O$, for which, below a certain critical temperature (0·004°, 0·03°, 0·12°, 0·04°K respectively), the susceptibility is strongly field dependent but almost independent of temperature, and for which a slight magnetic hysteresis was observed. The susceptibility and absorption coefficient was measured as a function of entropy at acoustical frequencies. The remanence was measured as a function of the applied field and found to decrease as the latter increases. The hysteresis effects are believed to be due to secondary causes.

E. P. WOHLFARTH

538.221 : 536.48

6349. Antiferromagnetism at low temperatures. N. KÜRTI. *J. Phys. Radium*, **12,** 281–90 (*March*, 1951) *In French.*

A brief review of the adiabatic demagnetization process is followed by an account of the magnetic and thermal properties of some salts of the Fe group at very low temperatures, such as antiferromagnetic behaviour, magnetic hysteresis and remanence, and the field variation of entropy and magnetization below the transformation temperature. Detailed results are given for $FeNH_4(SO_4)_2 \cdot 12H_2O$. The results are discussed in the light of present theoretical knowledge (Van Vleck, Onsager). E. P. WOHLFARTH

538.221 : 538.24

6350. An antiferromagnetic transition curve in a cobalt Tutton salt below 0·1°K. C. G. B. GARRETT. *J. Phys. Radium*, **12,** 219–21 (*March*, 1951) *In French.*

Experiments on a single-crystal specimen indicate that below the Curie point (0·084°K) the antiferromagnetic state can only exist in low fields, the critical field value depending on the temperature as in superconductivity. Application of a theoretical treatment by Sauer and Temperley. E. P. WOHLFARTH

538.221 : 548.73

6351. Recent investigations of the crystallography of ferrites. E. F. BERTAUT. *J. Phys. Radium*, **12,** 252–5 (*March*, 1951) *In French.*

An account of X-ray measurements of the distribution of the metallic ions in ferrites among the "A and B sites," and a comparison of the results with those obtained from magnetic investigations [cf. Bertaut, *C.R. Acad. Sci., Paris*, **230,** 213 (1950)]. E. P. WOHLFARTH

538.222

6352. Measurement of the relaxation time T_2 in the presence of an inhomogeneity in the magnetic field more important than the width of the line. R. GABILLARD. *C.R. Acad. Sci., Paris*, **232,** 1551–3 (*April* 23, 1951) *In French.*

If the variation of H is uniform in the volume occupied by the sample, $T_2 = t_0/ln(L_1/\pi L_2)$ where $L_1 L_2$ are the amplitudes of the signal at the first and second maximum which are separated by a time t_0. For any variation of H, if T_2 is larger than the half-period $T_0/2$ of the sweep, the signal has oscillations of amplitude near the resonance. If L_1 and L_2 are the amplitudes before and after passing through the resonance, $T_2 = T_0/ln(L_1/L_2)$. Both methods were employed successfully. L. PINCHERLE

538.242

6353. Investigation of the gyromagnetic effect with a classical resonance method. F. GALPERIN AND T. PEREKALINA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 6) 821–3 (1951) *In Russian.*

Measurements of g from the damping effect of a magnetic field on a mechanical oscillatory system gives mean values of 1·98 for Ni, 1·85 for CrTe and 1·99 for $MnCu_2Al$. D. H. WHIFFEN

538.245 : 539.217

6354. The kinetics of the change of energetic anisotropy on superstructure transitions. N. S. AKULOV AND E. P. SVIRINA. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 5) 669–71 (1951) *In Russian.*

It is found experimentally that K, the constant of energetic anisotropy, for molybdenum permalloy (77·5% Ni, ~ 3% Mo, ~ 19·5% Fe) depends on the degree of ordering σ as given by $K = K_0(1 + a\sigma)^n$. K_0 is the value of K at $\sigma = 0$ and a is a constant. A theoretical explanation is given [N. S. Akulov, *Ferromagnetism* (1939) *p.* 169; *Dokl. Akad. Nauk*, **66** (*No.* 3) (1949); Abstr. 5153 (1950)] based on the expression $K_\sigma = K_1(I_\sigma/I_1)^n$ derived earlier (I being the magnetization and $n \geqslant 10$). A. L. MACKAY

538.245 : 621.3.014 : 621.318.1.013

6355. Relaxation methods applied to the problem of a.c. magnetization of ferromagnetic laminae. O. I. BUTLER AND M. R. SARMA. *Proc. Instn Elect. Engrs, Pt II*, **98,** 389–98 (*June*, 1951). [*Reprint No.* 1026.]

For abstract see Abstr. 1940 (1951).

538.247

6356. Ballistic demagnetization coefficient for prismatic bars. M. A. ROZENBLAT. *J. Tech. Phys., USSR*, **20,** 1117–20 (*Sept.*, 1950) *In Russian.*

Such demagnetization factors have been given by Arkadiev and Sondheimer, and were based on the inscribed ellipsoid of revolution and three-axed ellipsoid, respectively. The new formula presented is also based on a three-axed ellipsoid of the same length, cross-section, but also the same mean perimeter as the prismatic bar, and takes the form $N = 16\,\delta d/l^2(\log \pi\chi l/(\delta + d) - 1)$, where the shape factor χ depends on the ratio of the axes a/b of the ellipsoid and is computed by elliptic integrals. Comparison with experimental results and the same special cases calculated by the older formulae shows the considerable improvement in accuracy achieved; an estimate of the theoretical error shows that it will always lie within admissible limits, which does not apply to the other formulae. The experimental determination of the ballistic demagnetization factor was made on permalloy and transformer sheet strips as such, compared with toroids composed of such sheet material. B. F. KRAUS

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

6357. Ohm's law in moving bodies. T. SCHLOMKA. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 246–52 (1951) *In German.*

Weyl's and Becker's omission of the last term in the equation $\boldsymbol{G} = \sigma(1 - u^2/c^2)^{-\frac{1}{2}}\{\boldsymbol{E} + \boldsymbol{u}x\boldsymbol{B} - c^{-2}(\boldsymbol{E}.\boldsymbol{u})\boldsymbol{u}\}$ for the conduction current in a body moving with velocity $\boldsymbol{u}$ is criticized by investigating the behaviour of $\boldsymbol{G}$ under a Lorentz transformation. It is also shown that the equation can be expressed as $u_k s^{ik} = \sigma u_k F^{ik}$, where u_k is the 4-vector velocity, F^{ik} the electromagnetic tensor $(c\boldsymbol{B}; -\boldsymbol{E})$ and s^{ik} the tensor $(1 - u^2/c^2)^{-\frac{1}{2}}(c^{-1}\boldsymbol{u}x\boldsymbol{G}; -\boldsymbol{G})$. R. A. NEWING

538.3 : 530.145

6358. On the elimination of divergences from classical electrodynamics. J. W. GARDNER. Letter in *Proc. Phys. Soc. Lond., A*, **64,** 427 (*April*, 1951).

The equivalence of Dirac's theory and that of Gupta [Abstr. 2842 (1951)] can be established directly. G. J. KYNCH

538.3 : 530.145

The reciprocity theory of electrodynamics. *See Abstr.* 6026

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 621.396.616 : 621.387

6359. Electron plasma oscillations. G. WEHNER. *J. Appl. Phys.*, **22,** 761–5 (*June*, 1951).

Electron plasma oscillations are excited by a beam of fast electrons in a stabilized low-pressure Hg discharge. Probe measurements reveal that the u.h.f. fields are localized in thin layers, the plasma density and frequency of which follow Langmuir's law. The beam of fast electrons traversing such an oscillation layer becomes velocity-modulated, and excitation conditions result from drift time and bunching considerations similar to those in a klystron. A sealed-off tube described covers a frequency range between 800 and 4 000 Mc/s (five modes) without changing or matching any resonance circuit. A.

538.566

6360. Transient electromagnetic propagation in a conducting medium. J. R. WAIT. *Geophysics*, **16,** 213–21 (*April*, 1951).

The transient electric fields are calculated for several types of step function current sources embedded in a conducting medium. These are developed by the aid of the Laplace Transformation. The types of source elements considered are the electric dipole, the magnetic dipole and the linear grounded current element of finite and infinite length. A.

538.566 : 621.396.11

6361. On the nonspecular reflection of electromagnetic waves. V. TWERSKY. *J. Appl. Phys.*, **22,** 825–35 (*June*, 1951).

The nonspecular reflection of plane electromagnetic waves of arbitrary polarization by certain perfectly conducting surfaces composed of either semicylindrical or hemispherical bosses on an infinite plane is analysed. The results are compared in the plane of incidence and similarities between the analogous expressions for the distributions of semi-cylinders and hemispheres are noted. Expressions are obtained for the ratios of the components of the reflected intensity and radial energy flux polarized parallel and perpendicular to the plane of incidence as well as for the total intensity and radial energy flux for the case where the incident wave is unpolarized. It is found that for certain values of the parameters the reflected radiation may consist only of either the specular or the scattered contributions, while for

other values one of the scattered contributions, either the parallel or perpendicular component, may vanish. The results also indicate the occurrence of an extremum in the reflected radiation in the vicinity of the specular angle of reflection, which for certain ranges of the parameters for the small finite distributions may be a minimum rather than a maximum. For these cases there is also some critical angle of incidence (not necessarily $\pi/2$ or grazing incidence) for which the reflection at the specular angle is completely specular. The analogous distributions of cylinders and spheres are also considered. A.

538.566 : 621.392.2

6362. Propagation of waves along a co-axial spiral line in the presence of an electron beam. L. N. Loshakov. *J. Tech. Phys., USSR*, **19**, 578 (*May*, 1949) *In Russian.*

538.566 : 621.392.26

6363. Analysis of symmetrical waveguide junctions. D. M. Kerns. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 267–82 (*April*, 1951).

Previous theory of consequences of symmetry in waveguide junctions has made limited use of mathematical tools available in the theory of group representations and has been limited to the consideration of nondissipative junctions. In this paper group-theoretical technique is utilized more fully (in much the same way as in the analysis of the vibration of symmetrical molecules) in the formulation of an improved and general technique for the analysis of symmetrical waveguide junctions subject merely to the requirement of linearity. A waveguide junction, for the purpose of this paper, is a linear electromagnetic system possessing ideal waveguide leads, and is considered to be subject to excitation solely through the effects of nonattenuated modes in the waveguide leads. Under the conditions of the problem, an arbitrary electric (or magnetic) field in a waveguide junction is expressible linearly in terms of a finite number of linearly independent electric (or magnetic) basis fields. From any given ordered pair of electric (or magnetic) basis fields one can in principle calculate a complex number—an element of the admittance (or impedance) matrix characterizing the junction (relative to the choice of basis fields). The geometric concept of rotation and reflection of fields (and structures) is discussed in terms of a rotation-reflection operator, and the symmetry of a junction is characterized by a group of rotation-reflection operations under which the structure is invariant. A general procedure is given for the construction of a basis in which the basis fields transform according to irreducible representations of the symmetry group involved. Such basis fields are said to be of particular symmetry species and from the special properties of such fields follow the physical results, of which perhaps the most conspicuous is the vanishing of the matrix element between two fields of distinct symmetry species. A.

538.566 : 621.392.26

6364. On diffracting openings in electric guides. M. Jessel. *C.R. Acad. Sci., Paris*, **232**, 1546–8 (*April* 23, 1951) *In French.*

The wave diffracted in the interior of the guide is studied by assimilating to a quadrupole the section of the guide on whose side is the opening.

L. PINCHERLE

538.566 : 621.392.26

6365. On the representation of the electric and magnetic fields produced by currents and discontinuities in wave guides. I. N. Marcuvitz and J. Schwinger. *J. Appl. Phys.*, **22**, 806–19 (*June*, 1951).

Electromagnetic scattering problems in cylindrical waveguides, including free space, involve the calculation of the fields produced in the presence of geometrical discontinuities by arbitrary currents. Such discontinuities may be replaced by equivalent electric and magnetic currents. The over-all calculation then leads to two distinct problems: first, the calculation of the fields produced by the prescribed and induced currents in a discontinuity-free guide; second, the self-consistent determination of the induced currents by the condition that the fields so produced satisfy the boundary conditions at the discontinuity surfaces. The first problem is treated herein by representation of the fields in terms of a complete set of vector modes characteristic of the possible transverse field distributions in the guide cross-section. This representation transforms the over-all field problem into one-dimensional modal problems of conventional transmission-line form. The eigenvalue problem of finding the characteristic modes is discussed in detail for the case of a uniform guide with perfectly conducting walls. The transformation procedure and the solution of the resulting transmission-line problem are treated from an impedance point of view. A typical modal analysis and synthesis is presented for the explicit determination of the fields produced by arbitrary electric and magnetic currents in an infinite and semi-infinite waveguide of arbitrary cross-section. The connection with a corresponding dyadic Green's function representation (to be treated in Pt II) is pointed out. A.

538.566.2

6366. Wave packets, the Poynting vector, and energy flow. I. Non-dissipative (anisotropic) homogeneous media. C. O. Hines. *J. Geophys. Res.*, **56**, 63–72 (*March*, 1951).

Two methods for finding the energy velocity in electromagnetic propagation are in common use, the one employing wave packets and the other involving the Poynting vector. This paper deals only with non-dissipative media, in which the effective permittivity matrix, ε_{pq}, is Hermitian, that is, $\varepsilon_{pq} = \tilde{\varepsilon}_{qp}$. For such media, it is shown that the directions given by the two methods are the same, and hence either may be used for the direction of energy flow. A.

538.566.2 : 535.39

Propagation of waves in stratified medium. *See Abstr.* 6141

538.566.2 : 537.226

Reflection of radiowaves by water drops. *See Abstr.* 6192

538.566.2 : 621.396.11

6367. A v.h.f. propagation phenomenon associated with aurora. R. K. Moore. *J. Geophys. Res.*, **56**, 97–106 (*March*, 1951).

Anomalous propagation observed by radio amateurs at frequencies of 28 to 148 Mc/s during

displays of aurora polaris is described. The following features are characteristic: (1) a very high fading rate, such that voice modulation is rendered unintelligible; (2) directional antennas give best results when pointed toward the aurora; (3) lack of skip effect; (4) little change in polarization. Until more precise fading data are available, development of a suitable theory is deferred. A.

MAGNETIC EFFECTS 538.6

538.614 : 538.22

A note on the ferromagnetic Faraday effect at centimetre wavelengths. *See Abstr.* 6329

538.63 : 537.311 : 536.48

6368. Electrical resistance of some ferromagnetic metals [and alloys] in a magnetic field at low temperatures. C. J. GORTER. *J. Phys. Radium*, **12**, 279–80 (*March*, 1951) *In French.*

Reports measurements (by M. Smit) on Ni–Fe, Ni–Co and Ni–Cu and gives a curve relating the ratio $2(R_{||} - R_{\perp})/(R_{||} + R_{\perp})$ to the number of effective magnetic carriers per atom, $R_{||}$ and $R_{\perp}$ being the values of resistance with the field parallel and perpendicular to the current respectively.

E. P. WOHLFARTH

538.632

6369. Investigation of the Hall–Kikoin effect of dynamo steel in strong fields. N. M. GENKIN. *J. Exp. Theor. Phys., USSR*, **20**, 941–3 (*Oct.*, 1950) *In Russian.*

In fields below "technical" saturation there is a hysteresis of the Hall–Kikoin effect, whereas in the technical saturation region the Hall–Kikoin e.m.f. is independent of the field. In the region of the para-process the Hall–Kikoin e.m.f. increases linearly with field. Investigation of Hall effect in metals enables the number of conductivity electrons and sign of charge of the current carriers to be inferred from simple "classical" models. In ferromagnetics Hall e.m.f. is represented by $E = R_1 I_j$, where E is Hall e.m.f., I magnetization, j current density. B. F. KRAUS

538.632

6370. Hall constant of cadmium oxide. C. A. HOGARTH. Letter in *Nature, Lond.*, **167**, 521–2 (*March* 31, 1951).

Measurements on pressed-powder specimens were made for the temperature range 0–200°c and for O pressures from 760 to 4×10^{-3} mm Hg. The room temperature value ($\sim 2{\cdot}2$ cm^3/coulomb) remained substantially constant up to ~ 150°c and then decreased sharply. The variation with O pressure was in agreement with C. Wagner's general theory.

C. A. HOGARTH

538.639

6371. The saturation magneto-resistance of ferromagnetic alloys. R. PARKER. *Proc. Phys. Soc., Lond. A*, **64**, 447–52 (*May*, 1951).

It is suggested that the magneto-resistance coefficient of a ferromagnetic alloy is composed of two terms, one associated with the temperature-dependent, the other with the temperature-independent contribution to the electrical resistivity. An equation based on this hypothesis is in good agreement with the experimental results for silicon-iron alloys. The validity of the equation for other alloys is discussed.

A.

538.652

6372. Measurement of magnetostriction by wire strain gauges. D. I. VOLKOV AND V. I. SKOROBOGATOV. *J. Tech. Phys., USSR*, **20**, 1102–6 (*Sept.*, 1950) *In Russian.*

Measuring results for ferromagnetic materials are reported for magnetostriction and magnetic field strength obtained on annealed specimens of a Fe–Co alloy (bands $200\times z\times 0{\cdot}2$ mm). The bridge was operated at 2 000 c/s, the measuring elements had a constantan base and 241-ohm resistance. The results were checked by d.c. bridge tests with the same strain gauges, and full agreement was found. Good agreement also with results obtained with a mirror galvanometer. B. F. KRAUS

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 548.7

6373. Triple-dipole interaction. II. Cohesion in crystals of the rare gases. B. M. AXILROD. *J. Chem. Phys.*, **19**, 724–9 (*June*, 1951).

See Abstr. 6376 (1951). The dependence of the triple-interaction between three neutral atoms on the configuration of the latter suggests a possible explanation of the structure of the crystals of Ne, A, Kr and Xe. The latter crystallize in the face-centred cubic (f.c.c.) lattice, one of the two closest-packed structures, the other being the hexagonal closest-packed. The triple-dipole interaction was directly summed in both the f.c.c. and h.c.p. lattices for a cylindrical region whose radius and semi-altitude were about three tjmes the nearest-neighbour distance. The calculations, made on punched-card machines, are outlined. The triple-dipole interaction amounts to 2–9% of the cohesive energy for the crystals of the above rare gases. The difference in the triple-dipole interaction for the f.c.c. and h.c.p. lattice, although favouring the former structure, is $< 0{\cdot}01\%$ of the cohesive energy and hence cannot account for the structure of these rare gas solids. A.

MOLECULAR STRUCTURE 539.13

539.132

6374. Application of a modified quantum-mechanical cellular method to the hydrogen molecule. V. A. LEWINSON AND G. E. KIMBALL. *J. Chem. Phys.*, **19**, 690–3 (*June*, 1951).

The application to molecules of the cellular method of Wigner, Seitz and Slater has been tested by using

it, in modified form, to calculate the electronic binding energy of the H_2 molecule. The results are not better than those obtained by the Heitler–London and molecular-orbital methods, but they are good enough to suggest investigation of more complicated molecules, where the method may be more successful. A.

539.132

6375. Substituted methanes. VI. Force constants and calculated thermodynamic properties for some trifluoromethanes. C. E. Decker, A. G. Meister and F. F. Cleveland. *J. Chem. Phys.*, **19**, 784–8 (*June*, 1951).

For Part V see Abstr. 4262 (1951). Using previous Raman and infrared data, force constants were calculated for CF_4, CF_3H and CF_3Cl, by means of the Wilson *FG* matrix method, with a potential energy function containing all possible second-degree terms. Fundamental frequencies for CF_3D were then determined by means of the force constants found for CF_3H. Finally, the heat content, free energy, entropy and heat capacity for the ideal gaseous state at 1 atmos. pressure were calculated for these 4 molecules for 11 temperatures, from 100° to 1 000°K, with a rigid rotator, harmonic oscillator approximation. A.

539.132 : 533.72

6376. Triple-dipole interaction. I. Theory. B. M. Axilrod. *J. Chem. Phys.*, **19**, 719–24 (*June*, 1951).

Third-order perturbation theory is applied to the Van der Waals-type interaction between neutral atoms. An interaction between triplets of atoms results. The derivation of the third-order energy interaction W_0''', is outlined, the procedure being somewhat similar to that used by London in his application of second-order perturbation theory to interatomic interaction. Since the perturbing potential is limited to the dipole-dipole term, the energy W_0''' is called the triple-dipole interaction. The latter depends not only on the interatomic distances but also on the shape of the triangle formed by the three atoms; W_0''' is positive for all acute and negative for most obtuse triangles. See Abstr. 6373 (1951). A.

539.132 : 535.343–15

6377. On the hyperfine structure of the rotational spectra of XYZ_3-type molecule, where nuclei Z have electric quadrupole moments. M. Mizushima and T. Ito. *J. Chem. Phys.*, **19**, 739–44 (*June*, 1951).

Hyperfine structure due to the electric quadrupole moments of nuclei is calculated for a special molecule of XYZ_3 type, where nucleus Z has a spin larger than 1/2, and nueclei X and Y have no electric quadrupole moments. The number of the hyperfine structural lines is calculated group-theoretically for the cases where the spin of nucleus Z = 1, 3/2, 2, 5/2. The theoretical spectra of the $J = 0 \rightarrow 1$ transition are given for these cases. A.

539.132 : 535.343.2–15

6378. The vibrations of an infinitely long chain of CH_2-groups and the infra-red spectrum of polythene. L. Kellner. *Proc. Phys. Soc., Lond. A*, **64**, 521–35 (*June*, 1951).

An attempt has been made to interpret the infra-red spectrum of polythene as the spectrum of an infinitely long chain of CH_2-groups. The vibrations of such a chain have been calculated using a potential function which involves valence and angle forces as well as the torsional force resisting a twisting of the C–C bonds. The selection rules and states of polarization of the fourteen possible frequencies are derived. The observed bands are assigned to the calculated vibrations and the force constants are evaluated. It is shown that the oscillations involving the C–C valence force are weakly active in contradiction to the theory. In the last section, this activity has been ascribed to the presence of CH_3-groups at the ends of the polythene chain. A.

539.132 : 541.57

6379. Covalency, electrovalency and electronegativity. T. L. Cottrell and L. E. Sutton. *Proc. Roy. Soc. A*, **207**, 49–63 (*June* 7, 1951).

With a view to obtaining a clearer understanding of several generalizations concerning bond strength, calculations on a number of model molecules have been made. The Heitler–London–Sugiura treatment has been extended to systems of two nuclei and two electrons in which the nuclear charges are less than or greater than $+ 1e$, and in which they may or may not be equal. The results obtained help to resolve the apparent contradiction between Pauling's adjacent charge rule and Gordy's rule connecting electronegativities and bond strength. They also suggest that the importance of changes in internuclear repulsion is greater, and that of changes in ionic contributions is less, in causing the relative stabilization of molecules with unequal centres, than supposed. They lead, however, to an expression for this stabilization similar in form to Pauling's, and so provide a new basis for interpreting atomic electronegativities. A.

539.132 : 541.57

6380. Bond lengths in conjugated molecules: the present position. C. A. Coulson. *Proc. Roy. Soc. A*, **207**, 91–100 (*June* 7, 1951).

A survey is given of the present methods for calculating bond lengths in conjugated molecules. Except in simple cases this has to be achieved by combining a calculated bond order with a semi-empirical relation between order and length. There are several definitions of bond order in current use, some of which can be shown to be less valuable than others. Recent accurate X-ray analysis has shown convincingly that the concept of bond order is a valid one, though there are limits to the degree of accuracy that may be claimed. Several possible improvements upon the simple theory are mentioned, most of which indicate alterations in bond lengths calculated from the simple theory, of the order of 0·005 Å. It is concluded that for condensed hydrocarbon molecules, the lengths of individual bonds may be predicted to within about 0·015 Å. For heteromolecules there are still too many additional factors for any reliable estimate to be possible. A.

539.133

6381. Hybrid orbits for coordination numbers 7 and 9. M. G. Shirmazan and M. E. Dyakina. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 1) 75–6 (1951) *In Russian.*

Using Kimball's method 2 configurations are examined: (i) with coord. No. 7, a pentagonal

bipyramid, symmetry D_{5h}, (ii) with coord. No. 9, a trigonal prism having atoms above the centres of right-angled faces, symmetry D_{3h}. Reduction tables show how 7 and 9 σ-bonds resp. can arise in hybridizations of *s*-, *p*-, *d*-, and in all but one case, *f*-electrons.

J. JACOBS

539.133

6382. The vibrational spectra of molecules and complex ions in crystals. V. Ammonia and deutero-ammonia. F. P. READING AND D. F. HORNIG. *J. Chem. Phys.*, **19**, 594–601 (*May*, 1951).

Abstr. 5699 (1950), part IV. Infrared spectra of thin non-scattering films of NH_3 and ND_3 were obtained at $-190°$C. All 4 fundamentals of both compounds were observed with no evidence of inversion doubling of ν_2. The crystal spectrum of NH_3 suggests a frequency near 3 450 cm^{-1} for ν_3 in the gas. The spectra are in agreement with a molecular crystal having the reported X-ray symmetry T^4. Two of the 5 torsional lattice vibrations were probably observed directly and one more strongly indicated in combination bands. A 4th lattice frequency of 53 cm^{-1} also occurs in combination bands. Since the coupling between the various internal vibrations and between the lattice and internal vibrations proved to be small, the potential function of the crystal was assumed to be separable into an internal and a lattice problem. A normal coordinate treatment of the internal vibrations fits all frequencies to better than 1%.

A.

539.133 : 535.343.4–14

The micro-wave spectra, structure, and dipole moments of ethylene oxide and ethylene sulfide. *See Abstr.* 6126

539.133 : 536.75

6383. Notes on the calculation of the entropy of molecules from spectroscopic data. T. PIETER. *Verh. K. Vlaamse Acad. Wetensch., Belg.*, **11** (*No.* 28) 110 *pp.* (1949). *In Dutch.*

The translational, rotational and vibrational entropy are calculated for the methane series up to dodecane, and the rotational entropies are compared with Huggins' results [*J. Chem. Phys.*, **8**, 181–7 (*Feb.*, 1940)]. The entropy due to internal movements, and rotations of groups with respect to each other is calculated; the results are in accordance with the law $S = 44{\cdot}5 + 10n$. Rotational and translational entropy is calculated for tetrahedral molecules, and the frequencies and vibrational entropies by a simpler method.

C. TURNER

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

6384. Measurement of transverse nuclear magnetic relaxation. G.-J. BÉNÉ, P.-M. DENIS AND R.-C. EXTERMANN. *Arch. Sci.*, **3** (*No.* 6) 452–5 (1950) *In French.*

The effect of the inhomogeneity of the field on the form of the signal was studied on a water solution of nickel sulphate by means of Helmholtz coils. It is equivalent to an apparent relaxation time T', so that, if T is the true transverse relaxation time, the measured value T'' is given by $1/T'' = 1/T + 1/T'$. Experiments of this type may provide a method for the absolute determination of T.

L. PINCHERLE

539.152.1

6385. The properties of the nuclear quadrupole moments of copper isotopes. G. BECKER AND H. KRÜGER. Letter in *Naturwissenschaften*, **38** (*No.* 5) 121–2 (1951) *In German.*

Nuclear resonance experiments on a crystal of $K_3[Cu(CN)_4]$ showed that for Cu^{63} and Cu^{65} the resonance peak is split into three components, the central peak corresponding to the Larmor frequency and the two outer peaks having positions depending strongly on the orientation of the crystal relative to the magnetic field. The splitting is a consequence of interaction between the nuclear quadrupole moment and the inhomogeneous electric field; the observed angular dependence agrees well with that calculated and allows an estimate to be made of the ratio of the two quadrupole moments, viz. $Q^{63}/Q^{65} = 1{\cdot}084 \pm 0{\cdot}007$.

E. P. WOHLFARTH

539.152.1

6386. The energy levels of the highly excited N^{15} nucleus. W. STETTER AND W. BOTHE. *Z. Naturforsch.*, **6a**, 61–72 (*Feb.*, 1951) *In German.*

The energy levels are determined by measuring the energies, in a nitrogen-filled ionization chamber, of the protons and α-particles produced by neutrons from a Ra–Be source. Wall effects are minimized by having the main ionization chamber surrounded by a subsidiary chamber, which is connected to an anti-coincidence circuit, so that only particles with paths lying wholly within the main chamber are detected. 18 levels were observed in the N^{15} nucleus, with excitation energies between 10 and 19 MeV, above the ground state.

J. HUGHES

539.152.1

6387. Magic numbers and the missing elements technetium and promethium. H. E. SUESS. Letter in *Phys. Rev.*, **81**, 1071–9 (*March* 15, 1951).

β-decay energy measurements indicate that following the filling of the 50 and 82 neutron shells, isobars with odd N become stable at lower mass numbers than those with odd Z, with the result that certain odd Z elements are unstable against β-decay. The elements $Z = 43$ and 61 come into this category.

L. R. SHEPHERD

539.152.1

6388. The isomeric state of RaE. N. FEATHER. Letter in *Phil. Mag.*, **42**, 568–70 (*May*, 1951).

Difficulties associated with the abnormal relative slowness of the isomeric transition RaE*→RaE, H. M. Neuman, *et al.* [Abstr. 5219 (1950)], could be removed by assuming that in the isomeric state of the nucleus containing $(126 + 1)$ neutrons and $(82 + 1)$ protons the intranuclear formation of an α-particle is less difficult than in the ground state.

W. J. SWIATECKI

539.152.1

6389. *ft*-Values of β-decay and the shell models. M. Taketani, S. Nakamura, M. Umezawa, K. Ono and Y. Yamaguchi. Letter in *Phys. Rev.*, **82**, 441 (*May* 1, 1951).

539.152.1

6390. Nuclear magnetic moment of Rb^{85}, Rb^{87}, and I^{127}. E. Yasaitis and B. Smaller. Letter in *Phys. Rev.*, **82**, 750 (*June* 1, 1951).

Simultaneous nuclear resonance experiments give $f_H/f_{Rb^{85}} = 10{\cdot}357105 \pm 0{\cdot}000030$, $f_H/f_{Rb^{87}} = 3{\cdot}0561097 \pm 0{\cdot}0000055$, $f_H/f_{I^{127}} = 4{\cdot}99763 \pm 0{\cdot}00015$ where f is the Larmor precession frequency.

D. H. Whiffen

539.152.1

6391. On the low-states of He^5 and Li^5. R. K. Adair. Letter in *Phys. Rev.*, **82**, 750 (*June* 1, 1951).

The $p - \alpha$ and $n - \alpha$ scattering data appear to be consistent with charge-independent forces and a large spin-orbit coupling. W. J. Swiatecki

539.152.1

6392. The splitting of *l*-shells in heavy nuclei by the tensor interaction. J. Keilson. Letter in *Phys. Rev.*, **82**, 759 (*June* 1, 1951).

Estimated in connection with the spin-orbit coupling required to explain "magic numbers."

W. J. Swiatecki

539.152.1 : 532.7

Nuclear magnetic resonance fine structure in liquids. *See Abstr.* 6066

539.153

6393. The electron affinity of the carbon atom. G. Glockler and J. W. Sausville. *J. Electrochem. Soc.*, **95**, 282–91 (*May*, 1949).

The electron affinity of the C atom is estimated to be 2·2 eV from linear extrapolation of the ionization potentials of the isoelectronic sequence C^-, N, O^+, F^{++} and Ne^{+++}. Experimentally it is shown that a C filament above 1 850°K gives off negative ions under proper conditions. Assuming that these ions are C^- ions, the electron affinity of the C atom is determined to be $\sim 2{\cdot}8 \pm 0{\cdot}3$ eV if the heat of sublimation of C is taken to be 136 kcal and $\sim 2{\cdot}1 \pm 0{\cdot}3$ eV if the heat of sublimation of C is 124 kcal. A.

539.153

6394. On the experimental determination of the lifetimes of atomic energy states. G. Stephenson. *Proc. Phys. Soc., Lond. A*, **64**, 458–64 (*May*, 1951).

The lifetimes of certain atomic resonance states (Na, K, Rb, Tl) have been measured using a magnetic rotation method [Weingeroff, *Z. Phys.*, **67**, 679 (1931)] possessing the advantage of not requiring an accurate knowledge of the vapour pressure data. The experimental results are compared with theoretical values obtained using the recent Bates–Damgaard Coulomb approximation, and with results based on Hartree and Slater type wave functions. Good agreement is found with the Bates–Damgaard results. A.

539.154 : 536.631

6395. The atomic heats of the rare-earth elements. D. H. Parkinson, F. E. Simon and F. H. Spedding. *Proc. Roy. Soc. A*, **207**, 137–55 (*June* 22, 1951).

The atomic heats of La, Ce, Pr and Nd have been measured from 2 to 180°K. La shows an anomaly corresponding to superconductivity at 4·37°K, and the atomic heat (C_p) rises to 6·2 cal/g atom at 180°K. The free electronic specific heat deduced from the low-temperature results appears to explain this high value satisfactorily. Ce, Pr and Nd all behave anomalously, which can be explained qualitatively by the view that the electronic states attributable to the $4f$ electrons are split by the electric fields existing within the metallic crystals. This effect is more complicated than with the magnetically dilute hydrated rare-earth salts, as magnetic interaction is probably very important. A.

539.155.2

6396. Tritium in nature. A. V. Grosse, W. M. Johnston, R. L. Wolfgang and W. F. Libby. *Science*, **113**, 1–2 (*Jan.* 5, 1951).

Measurement of the tritium content of several samples of highly concentrated heavy water gave the natural abundance of tritium in Norwegian surface waters as $\sim 10^{-18}$ mole/mole hydrogen.

A. O. Stanesby

539.155.2

6397. Masses of Al, Si, P and S isotopes. H. T. Motz. Letter in *Phys. Rev.*, **81**, 1061–2 (*March* 15, 1951).

An analysis has been made of recent mass-spectrograph data on these isotopes and of appropriate mass differences from recent *Q*-value determinations. Best-fit values are tabulated. T. G. Pickavance

539.155.4

6398. The atomic masses of H^1, D^2, and C^{12}. A. H. Wapstra. Letter in *Phys. Rev.*, **82**, 756 (*June* 1, 1951).

These are calculated from mass spectrograph mass doublets, and nuclear reaction energies. A slight discrepancy between the values calculated from some of the data is pointed out. J. Hughes

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

6399. Search for krypton of radioactive origin. E. K. Gerling and N. V. Baranovskaya. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 6) 825–6 (1951) *In Russian.*

No Kr could be detected in gases occluded in lepidolite and amazonite. Hence the soft X-rays emitted by Rb salts cannot be explained by the *K*-radioactivity of one of its isotopes. F. Lachman

539.16.08 : 519.24

6400. A new method of radioactive standard calibration. H. H. Seliger. *J. Res. Nat. Bur. Stand., Wash.*, **45**, 496–502 (*Dec.*, 1950).

By proper arrangement of experimental observations and statistical analysis it has been possible to make Geiger-counter measurements of different

activity samples independent of intermittent disturbing effects. The results of 5 328 individual measurements, involving more than $1{\cdot}4\times10^8$ counts made by using a Latin square arrangement, are shown to have an error distribution identical with that expected from the statistical nature of the disintegration process. A completely worked out example of a calibration procedure is given, in which it has been possible to achieve a higher degree of accuracy in only 30% of the original counting time. A.

539.16.08 : 778.3

6401. The detection of rare α-activity with the help of the photographic plate. E. Broda and K. Jenkner. *Experientia*, **7** (*No.* 4) 121–7 (1951) *In German.*

Special emulsions are impregnated with solutions of substances to be tested for natural α-activity and "exposed" for a period after drying. The sensitivity of this method exceeds by several orders of magnitude that of the ionization chamber. Results are given for Ti, Rb, Zn, Sr, Mo, Cd, Cs, Pr, Nd, Pb and Bi. No new activities have been found but lower limits for the ½-lives have been set. It was shown that Sm does not emit a second group of rays and that no α-active isotope of 61 exists in nature. W. J. Swiatecki

539.163

6402. Nuclear data. K. Way, M. Wood and K. Thew. *Circ. Nat. Bur. Stand., Wash., No.* 499, *Suppl. No.* 1, 56 *pp* (*April* 25, 1951).

See Abstr. 2938 (1951). Data published between Jan. and July, 1950, are presented on sheets designed for interfiling with the previous volume. New classes of information included: Nuclear scattering lengths; packing fractions and mass differences; notes on isotope shifts; ranges of α-particles in photographic emulsion; information on nuclear reactions in the light elements, $Z \leqslant 20$. The last category is by far the largest, and can be taken as a supplement to the pre-1950 information contained in two recent compilations [Abstr. 2911–12 (1951)].

539.163.1 : 539.166

6403. An 8×10^{-10}-sec isomeric state in $_{76}Os^{186}$. F. K. McGowan. Letter in *Phys. Rev.*, **81,** 1066–7 (*March* 15, 1951).

The excited state of Os^{186} with an excitation energy of 137 keV has been found to have a half-life of $(8 \pm 1)\times10^{-10}$ sec, using a delayed coincidence scintillation spectrometer. The γ-radiation is probably electric quadrupole. A. O. Stanesby

539.163.1/.2

6404. The uranium isotope U^{236}. A. Ghiorso, J. W. Brittain, W. M. Manning and G. T. Seaborg. Letter in *Phys. Rev.*, **82,** 558 (*May* 15, 1951).

A sample of enriched U^{235}, strongly irradiated with slow neutrons, was examined with the α-pulse-analyser, and a group of α-particles of energy $\sim 4{\cdot}5$ MeV was attributed to U^{236}; the α-½-life is $\sim 2\times10^7$ yr. A. O. Stanesby

539.163.1/.2 : 539.185

6405. Neutron-induced isomers of xenon: a new isomer of xenon-129. I. Bergström. *Nature, Lond.*, **167,** 634–5 (*April* 21, 1951).

Xenon was irradiated in a pile (Bepo), the Xe isotopes separated electromagnetically, and those of $A = 127$, 129, 131 and 133 examined in a β-spectrograph. An isomer of Xe^{129} ($T_{\frac{1}{2}} = 8{\cdot}0 \pm 0{\cdot}2$ days: γ-energy of transition = 196 ± 2 keV) was discovered. A. O. Stanesby

539.163.1.08

6406. On measuring very short half-lives. Z. Bay, R. R. Meijer and G. Papp. Letter in *Phys. Rev.*, **82,** 754 (*June* 1, 1951).

The application of a differential coincidence counting system to the direct measurement of ½-lives $\sim 10^{-10}$ sec. A. O. Stanesby

539.163.2

6407. On the disintegration of scandium (46) and the method of delayed coincidence for the study of short-lived metastable states in isomeric nuclei. B. D. Nag, S. Sen and S. Chatterjee. *Indian J. Phys.*, **24,** 479–96 (*Nov.*, 1950).

A metastable state having a half-life of $12{\cdot}15 \pm 0{\cdot}2$ μsec has been found in Ti^{46} decaying from 85 days Sc^{46}. The method of delayed coincidence used for the purpose has been discussed with reference to the effect of time-lag in G.M. counters. The distribution function for the time-lag is found to differ from the Gaussian error function. A mathematical expression relating the decay constant of the metastable state to the delay in one of the channels has been derived assuming a Gaussian distribution of the initial pulses as a first approximation. The disintegration scheme of Sc^{46} has been examined. The two beta rays were separated by means of Al absorbers and the values of their energy maxima were obtained as 0·34 MeV and 1·52 MeV from the Feather plots. This confirms the results obtained by Walke, Peacock and Wilkinson. A.

539.163.2

6408. The 43-day isomer of cadmium (115). P. S. Gill, C. E. Mandeville and E. Shapiro. *Indian J. Phys.*, **24,** 566–70 (*Dec.*, 1950).

The 43-day activity of Cd^{115} was induced in pure metallic Cd irradiated by slow neutrons in the Oak Ridge pile. After chemical purification, the radiations were analysed with the utilization of conventional absorption and coincidence techniques. It is concluded that the 43-day activity decays with the emission of beta rays of energy 1·41 MeV and at least two gamma rays having respectively energies of 0·10 MeV and 1·10 MeV. These gamma rays are coincident with an inner beta spectrum having an end point at approximately 0·38 MeV. The beta-gamma coincidence data show that only 0·85% of the total beta radiation is contained in the softer group. Gamma-gamma coincidences indicate cascade emission of gamma rays. A.

539.163.2

6409. Disintegrations of Nd^{147} and Pm^{149}. E. Kondaiah. Letter in *Phys. Rev.*, **81,** 1056–7 (*March* 15, 1951).

A decay scheme is constructed on the basis of β-spectrometer studies. W. J. Swiatecki

539.163.2

6410. Positron search in K^{40}. M. L. Good. Letter in *Phys. Rev.*, **81,** 1058–9 (*March* 15, 1951).

Annihilation quanta from K^{40} were sought by

comparison with Zn^{65}, using a scintillation counter [see Abstr. 5725 (1951)]. Not more than ~ 1 positron is emitted per 100 γ-rays. A. O. STANESBY

539.163.2

6411. The positron activity of K^{40}. S. A. COLGATE. Letter in *Phys. Rev.*, **81**, 1063–4 (*March* 15, 1951).

Coincidences between annihilation quanta from K^{40} were sought using two scintillation counters: an upper limit of 1 positron emitted per 1 700 electrons was found. A. O. STANESBY

539.163.2

6412. The disintegration scheme of I^{131}. P. R. BELL, J. M. CASSIDY AND G. G. KELLEY. Letter in *Phys. Rev.*, **82**, 103–5 (*April* 1, 1951).

γ-γ- and β-γ-coincidence measurements were made using a scintillation spectrometer; a level scheme is given. A. O. STANESBY

539.163.2

6413. On the decay of $Xe^{125} \rightarrow I^{125} \rightarrow Te^{125}$. I. BERGSTRÖM. Letter in *Phys. Rev.*, **82**, 111–12 (*April* 1, 1951).

Separated Xe^{125} was examined in a β-spectrometer, and a tentative level scheme is proposed: Xe^{125} decays predominantly by *K*-capture to several excited states of I^{125}, which then decay also by *K*-capture to the two excited states of Te^{125}. A. O. STANESBY

539.163.2

6414. On the radioactivity of chromium of mass 55. P. JORDAN, P. SCHERRER AND W. ZÜNTI. Letter in *Experientia*, **7**, 134–5 (*April* 15, 1951) *In French.*

The activity ascribed to Cr^{55} [Abstr. 761 (1948)] could not be observed from the reaction $Mn^{55}(n, p)Cr^{55}$ using Li + D neutrons. Possible explanations of this result are discussed. A. O. STANESBY

539.163.2

6415. Research into the coincidences between the β- and γ-rays in the disintegration spectrum of boron 12. G. VENDRYES. *C.R. Acad. Sci., Paris*, **232**, 1549–51 (*April* 23, 1951) *In French.*

Using coincidence absorption methods, it is found that in 5% of the disintegrations of B^{12}, a γ-ray accompanies a transition to an excited level of C^{12}, approx. 4·5 MeV above the ground state. J. HUGHES

539.163.2

6416. Evidence for the natural radioactivity of indium. S. G. COHEN. Letter in *Nature, Lond.*, **167**, 779 (*May* 12, 1951).

Results were consistent with the decay of In^{115} to Sn^{115} by β-emission ($E_{max} \sim 10^5$ eV) with a $\frac{1}{2}$-life of $\sim 10^{14}$yr and with the decay of In^{113} to Cd^{113} by *L*-electron capture with a $\frac{1}{2}$-life of $\sim 10^{12}$ yr. A. O. STANESBY

539.163.2

6417. Radioactivity of nickel. H. W. WILSON. Letter in *Phys. Rev.*, **82**, 548 (*May* 15, 1951).

The use of a stronger source confirms an earlier report [Abstr. 1273 (1951)] that Ni^{59} decays by a simple *K*-capture process. J. HUGHES

539.163.2

6418. Beta-decay of 7·5-day Ag^{111} to a 0·1 microsecond excited state of Cd^{111}. D. ENGELKEMEIR. Letter in *Phys. Rev.*, **82**, 552–3 (*May* 15, 1951).

Measurements of delayed β-γ-coincidences from Ag^{111}, using stilbene scintillation counters, justify the identification [Johansson, Abstr. 585 (1951)] of the 243-keV level of Cd^{111} formed by β-decay of Ag^{111} with the 0·09-μsec level observed in the *K*-capture decay of In^{111} and in the 48-m isomeric transition of Cd^{111*}. A. O. STANESBY

539.163.2

6419. Modes of disintegration of ionium: an investigation using β-sensitive emulsions. C. D. JARVIS AND M. A. S. ROSS. *Proc. Phys. Soc., Lond. A*, **64**, 535–45 (*June*, 1951).

Kodak NT 4 emulsion was impregnated in a neutral solution of ammonium ionium oxalate. Observations of α-particle and internal conversion electron tracks are interpreted in terms of excitation levels of the Ra nucleus at about 70 keV (22% intensity) and at about 200 and 270 keV (combined intensity about 2%). A disintegration scheme is proposed which allocates the known γ-ray of 68 $\pm$ 1 keV to the transition between the two highest levels. The results are reasonably consistent with recent α-ray magnetic analysis and γ-ray absorption measurements. A.

539.163.2

6420. Decay of Np^{236}. D. A. ORTH AND G. D. O'KELLEY. Letter in *Phys. Rev.*, **82**, 758 (*June* 1, 1951).

Scheme of decay to U^{236} and Pu^{236} determined by β-spectrometer and absorption measurements. W. J. SWIATECKI

539.163.2 : 551.510.41

Origin of atmospheric argon and the radioactive decay constants of potassium-40. *See Abstr.* 6623

539.164

6421. On alpha-disintegration: I. Some useful theoretical tabulations and graphical plots. R. K. DAS. *Indian J. Phys.*, **24**, 523–38 (*Dec.*, 1950).

Starting from the well-known mass-defect formula

$$\Delta M = \alpha A - \beta \frac{(N-Z)^2}{A} - \gamma A^{2/3} = \delta \frac{Z^2}{A^{1/3}}$$

an expression has been deduced for the total energy released in an α-disintegration. The calculation has been confined to groups of nuclides with $I = 44$, 45, 46, 47, 48, 49, 50, 51, 52 and 54. Useful theoretical data are given in 10 tables. β, γ, δ and Q curves are plotted on 10 separate graphs and their outstanding characteristics briefly discussed. A.

539.164 : 530.145.6

6422. The wave statistical theory of alpha-disintegration. K. C. KAR AND M. L. CHAUDHURY. *Indian J. Phys.*, **24**, 545–65 (*Dec.*, 1950).

According to this theory the alpha particles do not leak through the potential barrier by some unknown mechanism, but actually surmount the barrier as required by classical mechanics. And on coming out of the nucleus they are acted upon by a retarding attraction field of Yukawa type, which will obviously reduce the initial high energy to the low observed value. Instead of the usual wave equation, those from the principles of wave statistics, given by Kar (1940), have been taken, which give a physical interpretation for the internal mechanism of disintegration. A.

539.164.74 : 537.534.74

Scattering of alpha-particles by helium. *See Abstr.* 6268

539.165

6423. On the β^+/β^- branching-ratio of $^{80}_{35}Br$. J. LABERRIGUE-FROLOW. *C.R. Acad. Sci., Paris*, **232**, 1201–3 (*March* 19, 1951) *In French.*

Br^{80} was obtained in the form of NaBr by the Szilard–Chalmers reaction with slow neutrons on $CHBr_3$ and the emitted negative and positive electrons examined separately in a semi-circular focusing magnetic spectrometer. The max. energies are $E_{\beta^+ max} = 868 \pm 7$ keV, $E_{\beta^- max} = 2{\cdot}11 \pm 0{\cdot}01$ Mev, and the relative disintegration probabilities $\beta^+/\beta^- = 0{\cdot}028 \pm 0{\cdot}002$; $K/\beta^+ \sim 2$. A. O. STANESBY

539.165

6424. β-Spectrometer investigations on electromagnetically separated Xe^{135} and Kr^{79}. I. BERGSTRÖM. Letter in *Phys. Rev.*, **82**, 112–13 (*April* 1, 1951).

Both spectra are found to be allowed. *K*- and *L*-conversion lines, *K*-capture and β^+-emission are also investigated. W. J. SWIATECKI

539.165

6425. The beta-spectrum of Cl^{36}. H. W. FULBRIGHT AND J. C. D. MILTON. Letter in *Phys. Rev.*, **82**, 274 (*April* 15, 1951).

The β-spectrum obtained by using a high-pressure argon-filled proportional counter, differs from that of Wu and Feldman [Abstr. 1177 (1950)] in having fewer low-energy electrons. The shape may well be accounted for by a single (second order tensor, or second order vector) interaction. A. O. STANESBY

539.165

6426. Measurement of the soft part of the β-spectrum of radioactive thorium deposit. L. YA. SHAVTVALOV. *J. Exp. Theor. Phys., USSR*, **20** (*No.* 8) 684–7 (1950) *In Russian.*

The rays in the semi-circular focuser used pass near the edge of the circular poles. Aberration is thereby reduced, gathering power and resolving power (r.p.) increased, cf. the uniform field. The source-image distance was 18 cm; with width of source = 0·05 mm and of counter slit = 0·15 mm, the measured $(H\rho)/\Delta(H\rho) = 400$. Measurements of the Th(B + C + C″) spectrum were at r.p. = 100 and lines were found at 24·7 and 36·3 keV. From a source activated for 35 min their intensities grew to max. in ~ 3 hr, decaying together. Hence they could not arise from conversion in ThC. They are attributed to conversion of the known 40 keV γ-ray in L_1 and M_1 shells of ThC″ respectively. But coincidences between the 24·7 keV conversion electrons and the 2·62 MeV γ-rays of ThC″ → ThD show that a 40 keV γ-ray must also be converted in ThD. This agrees with Meitner and Philipp's [*Z. Phys.*, **80**, 277 (1933)] observation of the 24·7 keV line from ThC″ as well as from Th(C + C″). J. C. E. JENNINGS

539.165

6427. On an effect of internal recombination in β emission. M. FABRE DE LA RIPELLE. *C.R. Acad. Sci., Paris*, **232**, 1655–7 (*April* 30, 1951) *In French.*

The probability that an electron emitted in β decay should be captured into an electronic orbit before leaving the atom (the energy balance appearing as radiation) was found to be very small. W. J. SWIATECKI

539.165

6428. Beta-spectrum of Cl^{36}. C. S. WU AND L. FELDMAN. Letter in *Phys. Rev.*, **82**, 460 (*May* 1, 1951).

Measurements on the Cl^{36} β-spectrum reported previously by the same authors [Abstr. 1177 (1950)] were shown, then, to correspond to Marshaks D_2 correction factor. Since this corresponds to $\Delta J = \pm 3$ while recent measurements give Cl^{36} spin 2 (making $\Delta J = \pm 2$), however, a new attempt has been made to fit the spectrum to C_{2V} or C_{2T} correction factors. By suitable choice of matrix elements this is shown to be possible in the C_{2T} case. L. R. SHEPHERD

539.165/.166

6429. Energy of beta particles and photons from Ca^{45}, Zn^{65} and Co^{60} by absorption. L. SIMONS. *Comment. Phys. Math., Helsingfors*, **15**, *Paper* 9, 11 *pp.* (*Recd.* 1951).

The range and maximum energy of β-radiation from Ca^{45}, Zn^{65} and Co^{60} have been determined by absorption in Al. The half-thickness and energy of γ-radiation from Zn^{65} have also been determined. The range of the β-particles was determined according to Feater's analytical method described by Glendenin. A hypothesis by which the energy spectrum of β-radiation can be approximated from absorption measurements is also given. A comparision between the results obtained from absorption and beta-spectrogaphic measurements shows that even for maximum ranges of approximately 0·2 MeV the spectra agree at the maximum end. As a trial an energy spectrum on the basis of the β absorption is construed for Ca^{45}. The fact that the Fermi curve ends in a nearly straight line confirms in a way the correctness of the spectrum. In addition the Fermi diagram gives a maximum energy in agreement with the one obtained according to the Feather analysis. A.

539.165/.166

6430. β-spectrum of Ag^{110}. N. M. ANTONEVA, A. A. BASHILOV AND B. S. DZHELEPOV. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 1) 41–4 (1951) *In Russian.*

The spectrometer used was the "ketron" [Abstr. 4427 (1951)]. Source thicknesses for various parts of the spectrum were 0·6, 6 and 34 mg cm^{-2} carried on 3 μ zapon. Counter-slit and source widths were 0·8 mm; instrumental resolution was 0·5%. Three principal components of the β-spectrum have upper limits of 88 ± 3, 520 ± 10 and $2\,885 \pm 25$ keV and relative intensities 65, 33 and 2, the intensity of the soft component being doubtful. A Fermi plot shows changes of slope at about 1 400 and 2 000 keV, above which it is straight. The 2% relative intensity includes all 3 hard components. 25 conversion lines have been measured and their intensities and energies are tabulated. They are attributed to 14 γ-lines, that of lowest energy (116 ± 1 keV) being converted in Ag, the remainder in Cd. Ten of the 14 γ-lines were already known [Abstr. 4311 (1950)]; the new ones are 447, 618, 740 and 1 480 keV. J. C. E. JENNINGS

539.165/.166

6431. Radiations of Nd^{147}. W. S. EMMERICH AND J. D. KURBATOV. Letter in *Phys. Rev.*, **81**, 1062 (*March* 15, 1951).

Gamma-rays of 91, 320 and 534 keV, and beta

components with max. energies of 825 (± 15), 600 and 380 keV are reported, suggesting a total disintegration energy of ~915 keV. A. O. STANESBY

539.165/.166

6432. Radiations of Ag^{110}. M. GOODRICH. Letter in *Phys. Rev.*, **82,** 759–60 (*June* 1, 1951).

Ag^{110} ($\frac{1}{2}$-life 24 sec) was examined directly using a scintillation spectrometer; the complex β-spectrum has end-points at 2·82 and 2·24 (± 0·1) MeV, and there is a relatively strong γ-line at 0·66 ± 0·02 MeV, with a weaker one at ~ 0·9 MeV. This is in agreement with Siegbahn [Abstr. 4311 (1950)].

A. O. STANESBY

539.166

6433. γ-Radiation of Co^{60}. B. DZHELEPOV, N. ZHUKOVSKIĬ AND YU. KHOLNOV. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 2) 233–6 (1951) *In Russian.*

This was measured using the Compton-electron spectrometer of Abstr. 3377 (1950) with 2 mm slits before both counters, the walls of which were 17 μ cellophane. To reduce scattering, the spectrometer was filled with He at 32 cm Hg. The source was a 4 mm dia. Co cylinder, 8 mm long. Lines were found corresponding to the 2 γ-rays (1 171·5 ± 1·0 and 1 331·6 ± 1·0 keV) measured by Lind *et al.* [Abstr. 2659 (1950)]. These values were used for calibration as also were lines from RaC and ThC″ between 606 and 2 620 keV. Over this range the measured γ-energy was 5 ± 1% high. Relative intensity measurements have to be corrected for dependence on energy of (*a*) the angular distribution of the Compton electrons, (*b*) absorption of γ-rays in source and entrance window, (*c*) counter efficiency. It is concluded that the 2 principal lines have an intensity ratio 0·98 ± 0·04 which confirms that they are emitted in cascade. There are no other lines between 200 and 1 800 keV of > 5% of the intensity of the principal lines. J. C. E. JENNINGS

539.166

6434. On the radioactivity of Hf^{181} and Hf^{175}. A. HEDGRAN AND S. THULIN. Letter in *Phys. Rev.*, **81,** 1072 (*March* 15, 1951).

Electromagnetically separated samples of Hf^{181} and Hf^{175} were examined in a high-resolution β-spectrometer, and gamma-rays of 344·9 and 342·2 keV resp. were found. Intensity ratio measurements were made on the Hf^{181} disintegrations, differing from those of Chu and Wiedenbeck [Abstr. 2096 (1949)] but not contradicting their level scheme. A. O. STANESBY

539.166

6435. Study of low-energy gamma-radiations emitted from Pa^{231} and U^{234}. G. SCHARFF-GOLDHABER AND M. MCKEOWN. Letter in *Phys. Rev.*, **82,** 123–5 (*April* 1, 1951).

The low-energy electromagnetic radiation from U^{234} and Pa^{231} was examined in an argon-filled proportional counter, and shown to consist of the *L* X-rays of Th and Ac resp. In U^{234} they are probably due to highly converted γ-rays (not found) of 50–90 keV; in Pa^{231}, a γ-ray of 27 keV was obtained. A. O. STANESBY

539.166

6436. On the γ-γ-correlation with higher multipoles. D. L. FALKOFF. Letter in *Phys. Rev.*, **82,** 98–9 (*April* 1, 1951).

Specific results for some simple cases are given and a general method for obtaining more complete tabulations is indicated. W. J. SWIATECKI

539.166

6437. Measurement of isomeric transition energies with a scintillation spectrometer. E. DER MATEOSIAN AND M. GOLDHABER. Letter in *Phys. Rev.*, **82,** 115–16 (*April* 1, 1951).

The energies of γ-rays emitted in the isomeric transitions of Sc^{46m}, Se^{77m}, Rh^{104m}, Sb^{122m} and Hf^{179m} have been measured, using a Tl I-activated NaI crystal, and found to be 135, 150, 52, 68 and 215 keV respectively (estimated accuracy 10%). The γ spectrum from Ir^{192m} was also observed and appeared to be continuous. L. R. SHEPHERD

539.166

6438. Energy of the ThC″ 2·62 MeV gamma-ray. A. HEDGRAN. Letter in *Phys. Rev.*, **82,** 128–9 (*April* 1, 1951).

See also Abstr. 6442 (1951). The energy of the ThC″ γ-ray has been compared with that of annihilation radiation, and with the Au^{198} γ-ray; there is a discrepancy between the two results, and taking the Au^{198} γ-ray as known more accurately, the energy of the ThC″ γ-ray is 2·6158 ± 0·0015 MeV.

A. O. STANESBY

539.166

6439. Investigation of the γ-rays from polonium. M. A. GRACE, R. A. ALLEN, D. WEST AND H. HALBAN. *Proc. Phys. Soc., Lond. A*, **64,** 493–507 (*May*, 1951).

A method of standardizing Po sources by measurement of the number of γ-rays is described. The hard γ-radiation of 0·773 MeV energy emitted in the decay of Po^{210} has been found to have an intensity of $1·8 \pm 0·14 \times 10^{-5}$ quanta per α-particle. The internal conversion of this line to the extent of 6·7 ± 1·7% gives rise to *K* X-radiation of lead. No other soft radiation was detected. The decay scheme of Po is discussed. A.

539.166

6440. Three-crystal scintillation spectrometer. J. K. BAIR AND F. C. MAIENSCHEIN. Letter in *Rev. Sci. Instrum.*, **22,** 343–4 (*May*, 1951).

Measures γ-ray energies by pair production, a pulse due to a γ-ray being measured and counted only when both associated annihilation quanta are also recorded. The discrimination against Compton scattering is quite excellent. A. O. STANESBY

539.166

6441. The energy of the gamma-ray from Se^{77m}. R. CANADA, W. H. CUFFEY, A. E. LESSOR AND A. C. G. MITCHELL. Letter in *Phys. Rev.*, **82,** 750 (*June* 1, 1951).

Measured by observing the spectrum of the photoelectrons ejected from a Pb radiator, and of the internal conversion electrons, with a magnetic lens spectrometer, it was 159·9 ± 1·0 keV. J. HUGHES

539.166.83

6442. The discrepancy in the energy annihilation radiation and the possibility of electron-positron mass difference. A. HEDGRAN AND D. A. LIND. Letter in *Phys. Rev.*, **82**, 126–7 (*April* 1, 1951).

A comparison, using a double focusing spectrometer, of the energies of electrons ejected from the L_{111} shell of U by 411 keV Au^{198} γ-rays and those ejected from the K shell of U by annihilation radiation (from Cu^{64}) leads to a value of $510{\cdot}37 \pm 0{\cdot}14$ keV for the latter compared with $m_- c^2 \equiv 510{\cdot}96 \pm 0{\cdot}02$ keV. It is suggested that the positron may be lighter than the electron by $0{\cdot}0023\ m_-$.

L. R. SHEPHERD

539.167.3

6443. Preparation of Zn^{65} of high specific activity from copper bombarded with 16-MeV deuterons. C. J. MALETSKOS, E. W. BACKOFEN AND J. W. IRVINE, JR. Letter in *J. Chem. Phys.*, **19**, 796 (*June*, 1951).

NUCLEAR REACTIONS 539.17

539.172

6444. Influence of the atomic shell on nuclear angular correlation. H. FRAUENFELDER. Letter in *Phys. Rev.*, **82**, 549 (*May* 15, 1951).

The reduction of the angular correlation of successive nuclear reactions is proposed by ionizing or exciting the decaying atom, and preventing it for a sufficient length of time from returning to the ground state. Methods of achieving this are discussed.

P. T. LANDSBERG

539.172

6445. Influence of the atomic shell on nuclear angular correlation in Cd^{111}. H. AEPPLI, A. S. BISHOP, H. FRAUENFELDER, M. WALTER AND W. ZÜNTI. Letter in *Phys. Rev.*, **82**, 550 (*May* 15, 1951).

A previous suggestion (preceding Abstr.) is verified experimentally with respect to the γ-rays of Cd^{111}.

P. T. LANDSBERG

539.172

6446. On the theory of a nucleon cascade. H. MESSEL. *Commun. Dublin Inst. Adv. Stud., Ser. A, No. 7*, 103 *pp.* (1951).

The development and fluctuations of a nucleon cascade in homogeneous nuclear matter from a single high-energy nucleon is first solved and then generalized to include (*a*) a power spectrum of the incident nucleon energies, (*b*) inhomogeneous nuclear matter, and (*c*) ionization losses. Many special cases are displayed graphically. General agreement with experiments is obtained, but indications are found that the exponent in the power law in (*a*) should be decreased from the assumed $2{\cdot}7$ to $\sim 2{\cdot}1$.

W. J. SWIATECKI

539.172 : 530.162

6447. On the fluctuation of a nucleon cascade in homogeneous nuclear matter and calculation of average numbers. I. H. MESSEL. *Proc. Roy. Irish Acad.*, **54A** (*No.* 8) 125–35 (1951).

The 1st and 2nd moments of the nucleon cascade in homogeneous nuclear matter are evaluated. It is found that the results are very similar to those previously obtained for the electron-photon cascade, i.e. the fluctuation at the cascade maximum is that expected for a Poisson distribution, but deviates greatly from this on either side of the maximum. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 6310–11

539.172

6448. Production of γ-quanta and neutral mesons in the capture of π^--mesons by deuterons. B. IOFFE, A. RUDIK AND I. SHMUSHKEVICH. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 3) 403–6 (1951) *In Russian.*

Probabilities for various theoretical mechanisms are calculated. Comparison with observation leads to the conclusion that both π^- and π^0 mesons are pseudoscalar. E. P. GEORGE

539.172

6449. Interaction of pi-meson with carbon and aluminum nuclei. M. CAMAC, D. R. CORSON, R. M. LITTAUER, A. M. SHAPIRO, A. SILVERMAN, R. R. WILSON, AND W. M. WOODWARD. Letter in *Phys. Rev.*, **82**, 745 (*June* 1, 1951).

Interaction at $\sim$60 MeV gave rise to stars and large- and small-angle scattering in a cloud chamber (total of 73 events). W. J. SWIATECKI

539.172.11

6450. γ-Rays in the reaction $Be^9(\alpha, n)C^{12}$. K. P. ARTEMOV AND N. A. VLASOV. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 2) 225–7 (1951) *In Russian.*

A source of $5{\cdot}3$ MeV α-particles was deposited on a Pt foil and covered with a 10 mg.cm^{-2} layer of Be on 3–5 mg.cm^{-2} filter paper. This was put at the centre of a β-spectrometer and 4-fold coincidences were registered between pairs of counters at the respective foci of the internal-conversion positrons and electrons. From the maximum of the curve of coincidences v. energy, after correction for the instrumental line-shape, the γ-ray energy was found to be $4{\cdot}37 \pm 0{\cdot}07$ MeV. Covering the Be with 105 mg.cm^{-2} of Pb increased the number of coincidences but made resolution worse. Recent (1950) papers have reported γ-rays of $2{\cdot}5$–3 and of $7{\cdot}5$ MeV; these are not confirmed. If the softer one is present, its intensity must be $< \frac{1}{5}$ of that of the principal line, and the harder one $< \frac{1}{500}$. J. C. E. JENNINGS

539.172.11

6451. Experiments for determining the mean range of recoil nuclei in heavy lead halides. A. MURIN, B. LURE AND V. PAVLOV. *Dokl. Akad. Nauk, SSSR*, 77 (*No.* 2) 245–7 (1951) *In Russian.*

The recoils from α-ray bombardment of $PbCl_2$ and PbI_2 were measured and compared with theory.

E. P. GEORGE

539.172.13

6452. Evidence concerning the reaction $p + p \rightarrow \pi^+ + d$. F. S. CRAWFORD, JR, K. M. CROWE AND M. L. STEVENSON. Letter in *Phys. Rev.*, **82**, 97–8 (*April* 1, 1951).

Coincidences were observed between magnetically sorted mesons and deuterons, and the range spectrum of the deuterons resulting from 340 MeV protons is reported. E. P. GEORGE

539.172.13

6453. Q-Values of the (p, α) reactions in lithium-6, lithium-7 and nitrogen-15, and the $B\rho$ values of thorium C′ and polonium alpha-particles. E. R. COLLINS, C. D. MCKENZIE AND C. A. RAMM. Letter in *Nature, Lond.*, **167**, 682–3 (*April* 28, 1951).

539.172.13

6454. Angular distribution of the two gamma-rays from $Li^7(p, \gamma)Be^8$ reaction. M. B. STEARNS AND B. D. MCDANIEL. Letter in *Phys. Rev.*, **82**, 450 (*May* 1, 1951).

The 14 and 17 MeV γ-rays were observed by means of a pair spectrometer of $\pm 7°$ angular aperture at angles of 0°, 35° and 75°. Two proton beam energies of 1·15 MeV and 0·50 MeV were employed. The latter, with a thick target, gave most of its yield from reactions at the 440 keV resonance. It was found that the resonance radiations were isotropic but that the non-resonance radiations (at 1·15 MeV) were highly anisotropic. L. R. SHEPHERD

539.172.13

6455. Cross sections and Q-values for $C^{13} + D^{12}$ reactions. C. W. LI AND W. WHALING. Letter in *Phys. Rev.*, **82**, 122–3 (*April* 1, 1951).

Thin, 61%-enriched, C^{13} targets were bombarded with 1 MeV deuterons and the energies of the disintegration particles of the reactions $C^{13}(d, \alpha)B^{11}$, $C^{13}(d, p)C^{14}$ and $C^{13}(d, t)C^{12}$ were measured by means of a magnetic spectrometer and scintillation counters. The Q-values deduced were $5·164 \pm 0·006$, $5·940 \pm 0·004$ and $1·310 \pm 0·003$ MeV respectively and the differential cross-sections for the (d, α) and (d, t) reactions at 0·99 MeV and 90° were respectively 0·7 mb/steradian and 0·2 mb/steradian. A (d, α) reaction to a $2·107 \pm 0·017$ excited state of B^{11} was observed. L. R. SHEPHERD

539.172.13

6456. The reaction $^7Li(d, \alpha)$ and the ground state of He^5. A. P. FRENCH AND P. B. TREACY. *Proc. Phys. Soc., Lond. A*, **64**, 452–8 (*May*, 1951).

A differential ionization chamber with electron collection has been designed for the study of α-particle spectra. Two chambers of this type have been used to investigate α–α coincidences in the reaction $Li^7(d, \alpha n)He^4$. The results confirm that this process takes place, and the observed angular correlation of successive α-particles lends some support to the view that the virtual ground state of He^5 is $P_{3/2}$. A.

539.172.13

6457. Excitation function of $Ta^{181}(d, p)Ta^{182*}$. K.-H. SUN, F. A. PECJAK, R. A. CHARPIE AND J. E. NECHAJ. Letter in *Phys. Rev.*, **82**, 459 (*May* 1, 1951).

Determined by the "stack foil" technique using deuterons up to 15·0 MeV. W. J. SWIATECKI

539.172.13

6458. The excitation functions for $B^{10}(d, \alpha)Be^8$. W. D. WHITEHEAD. Letter in *Phys. Rev.*, **82**, 553–4 (*May* 15, 1951).

Determined for 0·5–1·6 MeV deuterons: a resonance in C^{12} at 26·1 MeV is indicated. The Q-values are $17·92 \pm 0·15$ MeV for the ground state and $15·19 \pm 0·15$ MeV for the first ($2·73 \pm 0·20$ MeV) excited state; the width of this level is $0·95 \pm 0·20$ MeV. The mass of Be^8 is $8·00780 \pm 0·0016$. A. O. STANESBY

539.172.13

6459. Neutron yield for the Li + T reactions. R. W. CREWS. Letter in *Phys. Rev.*, **82**, 100–1 (*April* 1, 1951).

Evaporated films of Li on Al and Wo were bombarded with tritons between 0·25 MeV and 2·10 MeV. A curve of the neutron yield at 0° shows apparent resonances at 0·84 MeV and 1·70 MeV triton energies. Angular distributions in the centre of mass system are given at two T energies, 0·728 MeV and 1·084 MeV. The total cross-section is found to be $\sim 0·5$ b at 0·728 MeV and averages $\sim 0·7$ b over the whole range. L. R. SHEPHERD

539.172.13

6460. Evidence for an excited state of He^5. W. T. LELAND AND H. M. AGNEW. Letter in *Phys. Rev.*, **82**, 559 (*May* 15, 1951).

Two distinct groups of neutrons are observed in the T–T reaction and one of these is attributed to the existence of an excited state of He^5. J. THEWLIS

539.172.3

6461. The photo-disintegration of Be by the high energy γ-rays. B. ARAKATSU, M. SONODA, Y. UEMURA, S. YASUMI AND Y. SAJI. *J. Phys. Soc. Japan*, **6**, 66–7 (*Jan.–Feb.*, 1951).

A proportional counter was used to detect the α-particles from the reaction produced in the Be-lined walls of the counter by the 17·6 MeV, Li γ-ray and the 6·13 MeV, F γ-ray. An uncoated counter was used to correct for neutrons, and a lead wall G.M. counter monitored the γ-ray intensity. Analysis of the α-particle distributions indicated that the ground state and the 7 MeV, excited state of Be^8, but not the 3 MeV, and 4·8 MeV, excited states were involved. J. HUGHES

539.172.3

6462. Threshold for photoneutron reaction in U^{238}. J. R. HUIZENGA, L. B. MAGNUSSON, P. R. FIELDS, M. H. STUDIER AND R. B. DUFFIELD. Letter in *Phys. Rev.*, **82**, 561 (*May* 15, 1951).

X-rays from the 22 MeV betatron at the University of Illinois were used to measure the threshold for the reaction $U^{238}(\gamma, n)U^{237}$. The value obtained was $5·97 \pm 0·10$ MeV. J. THEWLIS

539.172.3

6463. Production of photomesons. R. M. LITTAUER AND D. WALKER. Letter in *Phys. Rev.*, **82**, 746 (*June* 1, 1951).

Experimental cross-sections for π^+ and π^- for H, D, C, O, F, Al, S, Ca, Bi. Proportionality to $A^{2/3}$ is found. W. J. SWIATECKI

539.172.4

6464. A note on the capture of fast neutrons by atomic nuclei. Y. ODA. *Sci. Pap. Osaka Univ., No.* 8, 3 *pp.* (1949).

Absolute values of capture cross-sections for Al^{27}, Cu^{65}, Rh^{103}, $Ag^{107, 109}$ for 2·5 MeV neutrons were determined using G.M. counters to detect β-activities of the resulting isotopes. Fair agreement with Reddemann's relative values is obtained [H. Reddemann, *Nature, Lond.*, **142**, 124 (1938)], but Bethe's theoretical estimates using the liquid drop model [H. A. Bethe, *Rev. Mod. Phys.*, **9**, 69 (1937)] are 10–100 times smaller. W. J. SWIATECKI

539.172.4

6465. Disintegration of neon by fast neutrons. C. H. JOHNSON, C. K. BOCKELMAN AND H. H. BARSCHALL. Letter in *Phys. Rev.*, **82**, 117–18 (*April* 1, 1951).

The neon was contained in a proportional counter at 30 atmos. and was irradiated by neutrons from a thin T target bombarded with protons. Pulse-height analysis of the resulting $Ne(n, \alpha)$ disintegration pulses in the counter, yielded a value of $0{\cdot}75 \pm 0{\cdot}05$ MeV for the threshold energy. The cross-section was measured over a neutron energy range 1·8–3·3 MeV and prominent resonances were observed at 2·45, 2·87 and 3·26 MeV. The reaction is attributed to Ne^{20}. L. R. SHEPHERD

539.172.4

6466. Slow neutron cross-section of bromine. P. A. EGELSTAFF AND B. T. TAYLOR. Letter in *Nature, Lond.*, **167**, 683 (*April* 28, 1951).

539.172.4

6467. An example of the $(n, p; \pi^-)$ reaction in the photographic emulsion. S. J. GOLDSACK AND N. PAGE. Letter in *Phil. Mag.*, **42**, 570–2 (*May*, 1951).

The event was observed in Ilford G5 emulsion exposed in a magnetic field of 34 000 gauss at 2 860 m altitude. Mechanisms for single meson production are discussed. E. P. GEORGE

539.172.4

6468. The thermal neutron capture cross section of Co^{59}. L. YAFFE, R. C. HAWKINS, W. F. MERRITT AND J. H. CRAVEN. Letter in *Phys. Rev.*, **82**, 553 (*May* 15, 1951). This was found to be $34{\cdot}2 \pm 1{\cdot}4$ barns. W. J. SWIATECKI

539.172.4

6469. Thermal neutron fission of Am^{241}. B. B. CUNNINGHAM AND A. GHIORSO. Letter in *Phys. Rev.*, **82**, 558 (*May* 15, 1951).

The cross-section, measured relative to that of Pu^{239}, was $3{\cdot}0 \pm 0{\cdot}2$ barns. The purification procedure is outlined. J. HUGHES

539.172.4

6470. BEPO. The larger experimental pile at Harwell. *Atomics, Lond.*, **2**, 176–81 (*June*, 1951).

A graphite and natural U reactor with a central thermal neutron flux of 10^{12} n/cm²/sec, it contains about 40 t of U metal in 1 ft × 0·9 in dia. Al canned "slugs," loaded into 900 horizontal channels to form a cylindrical reacting core in a 26 ft graphite cube. There are 20 slugs per channel, the channels running parallel through the graphite with a 7¼ in. square lattice pitch. The core forms a right cylinder of 20 ft dia. and length, the remaining graphite of the cube acting as a neutron reflector. The graphite cube (850 t) is built up of accurately machined blocks 7¼ in. square by 29 in long. The pile is surrounded by a 7 ft 6 in thick reinforced concrete biological shield with an inner thermal shield of iron 6 in thick. Cooling is by 180 000 ft³ of air/min drawn through by up to 4 1 400 h.p. exhausters, which keep the maximum U surface temperature down to 200°C at an operating power of 4 MW. Use of exhausters instead of compressors prevents the escape of airborne activity, the exhaust being expelled via a 200 ft stack, after filtering. Ingoing air is also filtered. Control is by 4 horizontal B_4C-filled steel tubes 2 in. in dia. and 10 similar shut-off rods operating vertically by compressed air. Experimental facilities include 2 thermal columns and a number of experimental holes through the pile. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

6471. On a disintegration of the positive heavy meson. E. F. PESSOA AND N. MARGEM. *An. Acad. Brasil. Ciênc.*, **22** (*No.* 4) 371–83 (1950) *In Portuguese.*

Two hundred cases of π^+-meson decay have been studied in nuclear emulsions G5. The mesons were produced by bombardment of carbon with 350 MeV protons from the Berkeley cyclotron. Combining the method of mass determination by the range and radius of curvature with the method of grain counting it was verified that in all cases the decay followed the scheme $\pi^+ \rightarrow \mu^+ + [\nu]$. L. PINCHERLE

539.18

6472. Production of μ-mesons by gamma-rays. P. A. WOLFF. Letter in *Phys. Rev.*, **81**, 1056 (*March* 15, 1951).

Theoretical. Assuming μ-pair coupling, the ratio of μ- to π-production by 322 MeV photons is calculated to lie between 0·11 and 0·06 E. P. GEORGE

539.18

6473. Meson to proton mass ratios. W. H. BARKAS, F. M. SMITH AND E. GARDNER. Letter in *Phys. Rev.*, **82**, 102 (*April* 1, 1951).

Refinements of previous work lead to the mass values: $\pi^+ = 277{\cdot}4 \pm 1{\cdot}1$, $\pi^- = 276{\cdot}1 \pm 1{\cdot}3$. E. P. GEORGE

539.18

6474. π^+ Meson mass determination. W. F. CARTWRIGHT. Letter in *Phys. Rev.*, **82**, 460 (*May* 1, 1951).

The π^+-mass is determined from the energy spectrum of mesons from proton-proton interaction. The observed spectrum fits closely that predicted when the product nucleons are in the triplet S-state, and the results are interpreted accordingly. J. G. WILSON

539.18

6475. Darling's theory and the mass of the π-meson. P. R. ZILSEL. Letter in *Phys. Rev.*, **82**, 557 (*May* 15, 1951).

An extension of Darling's theory [Abstr. 1595 (1951)] to bosons gives a π-meson mass of 271·5 m and predicts a 132 m π-type meson. W. J. SWIATECKI

539.18

6476. Energy spectrum of the electrons from μ^+ meson decay. R. SAGANE, W. L. GARDNER AND H. W. HUBBARD. Letter in *Phys. Rev.*, **82**, 557 (*May* 15, 1951).

This was measured, with π^+-mesons from 184 in cyclotron, using the spiral-orbit spectrometer. The

best fit is with the scheme $\mu^+ \rightarrow e^+ + 2\nu$ ($m_\nu \simeq 0$) with tensor coupling in the anti-symmetrical theory with charge exchange [Abstr. 3462 (1949)].

W. J. SWIATECKI

539.185

6477. On the diffusion of thermal neutrons. M. NUYENS AND C. GROSJEAN. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 3) 17 *pp.* (1950) *In Dutch.*

A new mathematical approach to the problem of the spatial distribution of thermal neutrons about a point source. It is assumed that all the neutrons have the same velocity, that the medium is infinite and homogeneous, and that the collisons are isotropic.

J. THEWLIS

539.185

6478. Experimental contribution to the study of the diffusion of thermal neutrons. H. L. REEL. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 13) 21 *pp.* (1950) *In Dutch.*

The diffusion length of thermal neutrons is measured in water and in solutions containing B, Cl, N, Mn and Li. A Ra–Be source is placed at the centre of a glass sphere which can be filled with water or a solution of Cd sulphate. The sphere as a whole is used as a source and the required diffusion lengths obtained by difference from measurements of neutron density.

J. THEWLIS

539.185

6479. On the space energy distribution of slowed-down neutrons. II. G. HOLTE. *Ark. Fys.*, **3**, *Paper* 14, 209–45 (1951).

Abstr. 4760 (1951) Pt I. This is calculated for an infinite, homogeneous slowing-down medium in which the mean free path is a function of the neutron energy. General expressions covering essentially all distances from the (point) source are given. Numerical applications to carbon and water are made.

W. J. SWIATECKI

539.185

6480. The 800-kV neutron generator of the University of Istanbul. F. E. YENIÇAY. *Nature, Lond.*, **167**, 765 (*May* 12, 1951).

The generator, made by Philips, provides target currents of about 170 μA of protons or deuterons at a voltage of 650 kV. The neutron emission at 600 kV and 130 μA, obtained by bombarding Be with deuterons, is estimated to be the equivalent of that obtained from 5 g of Ra–Be.

J. THEWLIS

539.185.08

6481. Detection of slow neutrons. R. HOFSTADTER, J. A. MCINTYRE, H. RODERICK AND H. I. WEST, JR. Letter in *Phys. Rev.*, **82**, 749 (*June* 1, 1951).

Describes the successful detection of slow neutrons by scintillation counters made of single crystals of LiI containing 1% TlI.

J. THEWLIS

539.185.08

6482. High-energy neutron threshold detectors. B. L. COHEN. *Nucleonics*, **8**, 29–33, 45 (*Feb.*, 1951).

A number of $(n, 2n)$ and (n, p) reactions leading to radioactive products are listed. The use of these as threshold detectors in fast neutron flux measurements is described briefly.

L. R. SHEPHERD

539.185.7

6483. Scattering of thermal neutrons by mercury. C. T. HIBDON, C. O. MUEHLHAUSE, G. R. RINGO AND T. R. ROBILLARD. Letter in *Phys. Rev.*, **82**, 560 (*May* 15, 1951).

Using the cross-sections for coherent and total scattering and absorption for thermal neutrons, and the potential scattering cross-section at 19·5 eV, the $-2{\cdot}0$ eV, resonance parameters in Hg^{199} were calculated. Although $J = 0$ is expected for the capture state, the present work favours $J = 1$.

J. HUGHES

539.185.7

6484. The angular distribution of 3 MeV neutrons scattered by protons and by deuterons. W. F. CAPLEHORN AND G. P. RUNDLE. *Proc. Phys. Soc., Lond. A*, **64**, 546–54 (*June*, 1951).

The angular distribution of scattering of 3 MeV neutrons by protons and by deuterons has been investigated with a Wilson cloud chamber. The results reveal an almost isotropic distribution for neutron-proton scattering and a strongly anisotropic distribution in the case of neutron-deuteron scattering. The experimental results are compared with the theoretical curves of Buckingham and Massey for the scattering of 2·5 MeV neutrons by deuterons.

A.

STRUCTURE OF SOLIDS 539.2

539.21

6485. Existence of superlattice $CuAu_3$. M. HIRABAYASHI. Note in *J. Phys. Soc. Japan*, **6**, 129–30 (*March–April*, 1951).

The evidence is based on sp. heat and X-ray measurements. The ordered alloy has a higher resistance than the disordered one.

A. D. LE CLAIRE

539.21 : 539.4 : 548.7

6486. The widened lattice interval and its essential role in the behavior of crystalline metal. D. P. SMITH. *Science*, **113**, 348–51 (*March* 30, 1951).

The experimental data relating to the solubility of H in Fe is set out in support of a network of widened intervals. These *rifts* are necessary to explain a variety of properties of strained metal, mechanical, magnetic and electrochemical. Their characteristics are tabulated.

A. J. KENNEDY

539.211

6487. The nature of the "viscous" fracture. V. A. PAVLOV AND M. B. YAKUTOVICH. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 1) 49–50 (1951) *In Russian.*

539.213.28 : 539.4.016.3 : 541.127.1

6488. An application of the absolute reaction rate theory to some problems in annealing. F. W. CAGLE, JR, AND H. EYRING. *J. Appl. Phys.*, **22**, 771–5 (*June*, 1951).

Absolute rate theory is combined with molecular models in the study of the annealing of metals and of

glass. It is possible to obtain expressions which are in close agreement with experimental data. Both the observed first-order data for metals and the second-order data for glass are predicted in this way. A virtue of the rate theory treatment is that it replaces the earlier macroscopic theories with a treatment in molecular terms. A.

539.216.1

6489. Fibre formation in synthetic polymers: methods and features. F. HAPPEY. *Brit. J. Appl. Phys.*, **2**, 117–26 (*May*, 1951).

539.217

6490. Diffusion of P^{32} and of S^{35} in sodium chloride. M. CHEMLA. *C.R. Acad. Sci., Paris*, **232**, 1553–5 (*April* 23, 1951) *In French.*

Sodium chloride when irradiated by rapid neutrons contains P^{32} and S^{35} produced by the nuclear reactions $Cl^{35}(n, \alpha)P^{32}$ and $Cl^{35}(n, p)S^{35}$, which diffuse towards the crystal surface at temperatures $\sim 650°$. Their distribution is determined by cutting the crystal, and measuring the activities of the sections. Two distribution curves are included for diffusions of $\frac{1}{4}$ hr and 7 hr at 660° in an atmosphere of N.

H. H. HODGSON

539.217

6491. On the volume diffusion of metals. G. J. DIENES. Letter in *J. Appl. Phys.*, **22**, 848–9 (*June*, 1951).

Recently published experimental results, particularly those of Fensham on Sn [Abstr. 1339–40 (1950)] are discussed in the light of the theories of the author [Abstr. 660 (1950)] and Zener [Abstr. 4773 (1950)].

539.217 : 542.2

6492. Studies on glass surfaces. I. Migration of alkali ions through the surface layer. S. KINUMAKI. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 405–11 (*April*, 1950).

Previous work, quoted, shows that Na ions in soda glass may be removed from the surface layers by leaching with water or dil. acids, but that at elevated temperatures the alkalinity of the surface is restored by the diffusion to it of Na ions from the interior. The rate of this diffusion is then an important factor in determining the chemical durability of glass at elevated temperatures. Samples of commercial soda–lime–silica glass, the surface alkali content of which had previously been reduced by 40 min exposure to steam, were annealed at a constant temperature (350°C, 400°C or 450°C) and the increase M in the alkali content of the surface determined after various times t. The measurements are well represented by the theoretically expected relation $M = \text{const.}\ t^{\frac{1}{2}} \exp(-E/RT)$, with E, the activation energy $= 12$ kcal/mole. The electrical conductivity of glass being also due to the migration of Na ions, a check on this value of E was made by determining the variation with temperature of the conductivity of samples of the same glass. The results satisfied the equation $\sigma = \sigma_0 \exp(-E/RT)$ with $E = 14$ kcal/mole. An electrolytic method for de-alkalizing the surface is described, which appears to be more effective than the steaming method, and is therefore of importance in improving the chemical durability of glass surfaces.

A. D. LE CLAIRE

539.22 : 536.63

6493. Relaxation of the long range order in β brass problem. Y. TAKAGI AND T. OGUCHI. *Bull. Tokyo Inst. Techn., Ser. B., No.* 3, 211–19 (1950).

Relaxation effects should be taken into account in calculating theoretically such quantities as the anomalous sp. ht. associated with order-disorder changes, for these are present in the experimental determinations of the sp. ht., where the alloy is not necessarily always in thermal equilibrium. Using Eyring's reaction rate theory and making some assumptions about the form of the associated partition functions, an expression is derived for the time rate of change of long-range order s in terms of the temperature T and the existing order. Graphical representations are given of the properties of this expression, and also of the variation of sp. ht. and s with T, as derived from the expression, for various rates of heating and cooling. The Bragg–Williams equations [*Proc. Roy. Soc., A*, **145**, 699–730 (*July* 2, 1934)] are derived from the theory for the special case of equilibrium. Previous experimental work is quoted which confirms qualitatively the predictions of the theory.

A. D. LE CLAIRE

539.22 : 536.63

6494. Relaxation of the long range and short range orders in β brass. Y. TAKAGI, T. OGUCHI AND G. SHIRANE. *Bull. Tokyo Inst. Techn., Ser. B, No.* 3, 220–6 (1950).

An extension and refinement of the previous abstract, to include short-range order, leading to closer agreement with experiment. Bethe's relations [*Proc. Roy. Soc. A*, **150**, 552–75 (*July* 1, 1935)] are derived from the theory for the special case of equilibrium. A. D. LE CLAIRE

539.232 : 539.27

6495. A study of sulphide films on copper by electron diffraction. H. TAZAKI AND S. KUWABARA. *J. Sci. Hiroshima Univ.*, **14**, 251–4 (*Sept.*, 1950).

Samples of electrolytic Cu held at a temperature T_1 in one part of a furnace were exposed to the action of S vapour whose pressure was determined by the temperature T_2 of S powder contained in another part of the furnace. Subsequent electron diffraction photographs of the surface of the Cu showed:— (1) when $T_1 = T_2 = 70 - 250$°C, CuS or Cu_2S appeared according as the quantity of S was large or small respectively; (2) when $T_1 = T_2 \simeq 150$°C, the CuS patterns revealed an orientation of the sulphide film with the (110) plane parallel to the Cu surface; (3) when $T_1 > T_2$ only Cu_2S appeared; (4) in case (3), an additional pattern was occasionally found similar in many respects, but not all, to that of $Cu_{1.8}S$ observed by Buerger; (5) when T_1 was $\gg T_2$ either a pattern of Cu or a mixed pattern of Cu and Cu_2S, changing to that of Cu only on further heating, was obtained; (6) for various experimental reasons, patterns for $T_1 < T_2$ were not obtained. The interplanar spacings of Cu_2S and CuS calculated from the

electron diffraction photographs agreed fairly well with those obtained from previous X-ray measurements [N. Alsen, *Geologiska Föreningens i Stockholm Forhandlingar* 53 (2) (1931)]. A. D. LE CLAIRE

539.234

6496. An alignment chart for computing the thicknesses of evaporated films. A. L. SCHOEN AND R. H. DAVIS. Letter in *J. Opt. Soc. Amer.*, **41**, 362–3 (*May*, 1951).

Describes a chart which serves as a convenient guide to the thicknesses of evaporated films in situations where the evaporation material and geometry are subject to frequent change. H. P. MYERS

539.27

6497. On the structure of graphite oxide soot. K. BEYERSDORFER. *Optik*, 7 (*No.* 4–6) 192–8 (1950) *In German.*

Electron microscopical examination of graphite oxide soot, consisting of very thin carbon lamellae, coated with evaporated Pt or Au indicated the existence of single crystals of 2 000 Å cross-section. Electron diffraction photographs of very small regions (4 μ) showed that the hexagonal crystallites were oriented. The thickness of the carbon lamellae was estimated to be 13–23 Å. Two parallel exposures of an evaporated Pt layer indicated a resolving power of 20 Å for the electrostatic electron microscope.

J. A. FRANKS

539.27

6498. A stereoscopic technique for use with an electron microscope. J. W. SHARPE. *Brit. J. Appl. Phys.*, **2**, 78–80 (*March*, 1951).

539.27

6499. An examination of weld metal by means of the electron microscope. J. J. BRUNT AND A. N. DOWNER. Letter in *Nature, Lond.*, **167**, 646–7 (*April* 21, 1951).

539.27

6500. Identification and crystal habit of chromium carbide, $Cr_{23}C_6$, as determined by electron diffraction. J. F. BROWN AND D. CLARK. Letter in *Nature, Lond.*, **167**, 728 (*May* 5, 1951).

Residues obtained by electrolytic extraction of 25/20 Cr–Ni steels are examined by electron diffraction and electron microscopy and positive identification is made of their nature and crystal habit. J. THEWLIS

539.27

6501. Applications of polystyrene particles in conjunction with shadow casting to the study of polished metallic surfaces. I.-M. FENG. *J. Appl. Phys.*, **22**, 820–4 (*June*, 1951).

This is a report of a study of polished metallic surfaces with the electron microscope. Negative collodion replicas were used in this experiment. The determination of width and depth of scratches by means of polystyrene particles and shadow casting is briefly discussed. Experimental results are summarized as follows: The effect of polishing pressure applied is that greater pressure gives wider and deeper scratches and also causes severer flow and distortion of metal near the scratch. In comparison with unidirectional polishing, multidirectional polishing gives better surface finish with fewer scratches: these scratches run in all directions and have a wide range of width and depth; mostly they are shallower and narrower than would be the case with unidirectional polishing. The average widths and depths of scratches on surfaces polished with various conditions are also given. Harder abrasives give a higher depth/width ratio.

539.2

6502. Modification of a positive-replica technique for electron microscopy. A. E. AUSTIN AND C. M. SCHWARTZ. Letter in *J. Appl. Phys.*, **22**, 847– (*June*, 1951).

539.27 : 548.

The observation of spiral growth-steps in *n*-paraffin single crystals in the electron microscope. *See Abstr.* 6561

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.3

6503. Atomic theory of elasticity. G. LEIBFRIED. *Z. Phys.*, **129** (*No.* 3) 307–16 (1951) *In German.*

This is a short note describing a method of extending Born's treatment of the atomic theory of crystals. Considering only small slow displacements of the individual atoms from their equilibrium position, a field equation is derived from which the elasticity equations can be deduced. The treatment is given both for a monatomic lattice and for the general case. H. J. H. STARK

539.3

6504. On some questions of hereditary elasticity. D. GRAFFI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 25–30 (*Jan.*, 1951) *In Italian.*

Particular solutions are studied of Volterra's integro-differential equations by determining the conditions under which the internal stresses are the same as in the non-hereditary case (though the displacements may be different). Important classes of elastic phenomena, including all plane systems, satisfy these conditions. L. PINCHERLE

539.312

6505. Damping of torsional oscillations of a ferromagnetic in a magnetic field. F. K. GORSKIĬ. *J. Tech. Phys., USSR*, **20**, 1111–16 (*Sept.*, 1950) *In Russian.*

Experimental confirmation of the proportionality of the losses, in the elastic hysteresis cycle in torsional oscillations of a Ni-wire, to the cube of the oscillation amplitude (Akulov's formula). Absorption coefficient in Akulov's formula proportional to differential permeability and equal, per unit volume, to $1{\cdot}21\times10^3\, dI/dH$ erg/cm^3. Young's modulus in dynamical conditions depends on magnetic field strength and is a minimum at the field strength corresponding to absorption maximum. B. F. KRAUS

539.312

6506. Visco-elasticity of rubber. R. B. BLIZARD. *J. Appl. Phys.*, **22**, 730–5 (*June*, 1951).

A theory has been obtained for the visco-elastic behaviour of rubber in the frequency range above

hat at which creep is important and below that at which it behaves like a hard solid. The rubber chains are treated as springs in a viscous medium, and a general expression is obtained for the contribution to modulus of a single section of chain as a function of its length and terminations. A statistical estimate is made of the number of chain segments having given length and terminations. A modulus function is found for the group of chains with each kind of termination and these are added in the proper amounts to give the form of the modulus *v.* frequency curve for any amount of cross-linking. Measurements of shear modulus were made on one apparatus at frequencies between 0·0125 and 750 c/s. Agreement is good if a pure viscosity is added to the theory. However, at low frequencies the imaginary part of modulus does not decrease as much as predicted. A.

539.32

6507. Stress-temperature studies of transitions in rubbers. R. S. WITTE AND R. L. ANTHONY. *J. Appl. Phys.*, **22**, 689–95 (*June*, 1951).

The stress-temperature method was employed as a means of studying the apparent "second-order" transition occurring in rubbers. Pronounced stress relaxation was observed at temperatures not too far below the transition region, but not at temperatures a few degrees above the transition. Comparison data were also obtained from volume dilatometric studies. With the exception of the data for natural rubber, the transition temperatures determined by the volume dilatometric method were somewhat lower than the lowest values obtained in the stress-temperature studies. A.

539.32

6508. Measurement of dynamic internal dissipation and elasticity of soft plastics. H. C. RORDEN AND A. GRIECO. *J. Appl. Phys.*, **22**, 842–5 (*June*, 1951).

In order to measure the mechanical properties of soft plastics over wide frequency and temperature ranges two new techniques have been devised. The first, which operates in the frequency range of a few cycles/sec, uses a horizontal oscillating pendulum. The shear impedance of the sample is measured by mounting a small pad of the material between the vibrating pendulum and a fixed platform and determining the change in frequency and the change in the decrement caused by the sample. The other, which is applicable in the frequency range from 100 to 10 000 c/s, makes use of a vibrating tuning fork. Two identical samples are mounted between a stationary weight and the moving tines, and the shear mechanical impedance is determined by determining the change in frequency and change in decrement caused by the specimen. These two techniques have been applied to measuring the shear properties of a number of soft plastics including Pyralin, Koroseal, Keldur, polyvinyl butyral, Thiokol and gum rubber. All of these show relaxation effects. The polyvinyl butyral appears to be approaching a crystalline elastic stage at the low frequency of 1 000 c/s, while gum rubber remains in a quasi-configurational stage from 2 to 1 000 c/s. A.

539.371

6509. Mechanics of large elastic deformations with special reference to rubber. R. S. RIVLIN. *Nature, Lond.*, **167**, 590–1 (*April* 14, 1951).

Summary of four lectures on the application of the mathematical theory of finite strain to rubber.

J. E. CAFFYN

539.373

6510. The deformation and ageing of mild steel. W. SYLWESTROWICZ AND E. O. HALL. *Proc. Phys. Soc., Lond. B*, **64**, 495–502 (*June*, 1951).

Mild steel deforms by a series of bands of plastic deformation called Lüders bands. In heavy tensile specimens a complex series of bands may arise, but in thin wire specimens it is shown that only single bands are formed. Measurements have been made of the propagation stress and Lüders strain for these single bands, and the effects which occur on ageing deformed specimens have been studied. A critical examination of current theories of the upper yield point—the stress at which bands first appear—is also undertaken. A.

539.374

6511. Peculiarities of the change of crystalline structure of a metal on deformation in surface-active media. V. N. ROZHANSKIĬ, T. A. AMFITEATROVA AND P. A. REBINDER. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 5) 697–8 (1951) *In Russian.*

Thin Cu wire was stretched in a 0·5% solution of oleic acid and in a 0·5% solution of cetyl alcohol, both solvents being kerosene. The degree of plastic deformation was found to be greater than that occurring in an inert medium. The number of grains also increased. It is thought that in a surface-active medium crystallites break down more easily into smaller grains and move more easily relative to one another. A. L. MACKAY

539.374

6512. The plastic theory of bending of mild steel beams with particular reference to the effect of shear forces. M. R. HORNE. *Proc. Roy. Soc. A*, **207**, 216–28 (*June* 22, 1951).

While the simple plastic theory of bending gives a satisfactory explanation of the observed behaviour of mild steel beams, it is open to various theoretical objections. These are examined by reference to the theory of perfectly plastic materials, and a special examination is made of the effect of shear forces, for which no allowance is made in the simple theory. The results are applied to beams of both rectangular and I section, and it is shown that the error involved in using the simple theory is small except for very short members. Experimental confirmation of the predicted configuration of slip surfaces in the web of an I beam is obtained by reference to tests performed by Frankl on welded connections. A.

539.389.3

6513. Recovery and recrystallization in highly stressed pure aluminium. E. A. OWEN AND Y. H. LIU. *Proc. Phys. Soc., Lond. B*, **64**, 386–96 (*May*, 1951).

An X-ray study of the phenomena observed when polycrystalline pure Al is subjected to heavy compressional stresses. The rate of recovery to the

metastable state under various conditions has been examined in some detail. During recovery recrystallization occurs; the crystals grow rapidly at first, but afterwards the rate of growth decreases until finally, after the metastable state has been reached, there are no further changes in crystal sizes. The recovery phenomenon and recrystallization are two different processes but they are not independent of each other. Crystals grow when the value of the stress varies from point to point in the material; when the stresses become evenly distributed, as is found to be the case in the metastable state, the crystals stop growing. The change from the state immediately following plastic deformation to the equilibrium crystalline state takes place in two stages, one brought about by strain energy and the other by thermal energy. The results are considered in the light of the dislocation theory. A.

539.42

6514. Relation of tensile strength to brittle temperature in plasticized polymers. R. F. BOYER. *J. Appl. Phys.*, **22**, 723–9 (*June*, 1951).

Since both the second-order transition temperature and the tensile strength of plasticized polymers decrease linearly with plasticizer content, and frequently in inverse proportion to the molecular weight of the plasticizer, it was predicted that a linear relationship should exist between tensile strength and transition temperature for plasticized polymers, independent of the nature of the plasticizer. Tensile strength *v.* heat distortion for four different plasticizers in polystyrene follows this prediction very well. However, tensile strength *v.* brittle temperature for plasticized Vinylite VYNW gives a different straight line for each plasticizer. It is suggested that the diffusion rate of a plasticizer molecule is important in the fast brittle point test. The hypothesis is proposed that the brittle temperature of a plasticized polymer represents an isodiffusion constant state. It follows on the basis of some semi-empirical equations that the brittle temperature should decrease linearly with plasticizer content, and inversely as the activation energy for diffusion of the plasticizer molecule in the plasticized polymer. This latter prediction appears in accord with existing data. This diffusion concept allows one to predict that the brittle temperature should increase linearly with logarithm of frequency of the test, but inversely as the activation energy for diffusion. A.

539.434

6515. Creep of metals. L. ROTHERHAM. *London, Institute of Physics*, 80 *pp.* (1951).

The subject is treated from the physical standpoint, and builds on the experimental framework set out by Andrade: the division into transient, steady-state and tertiary creep; the mechanisms of grain deformation and grain-boundary flow. General deductions from such investigations are considered in relation to the theoretical work of (in the main) Orowan and Mott, and the main results and methods of dislocation theory are set out. The subject matter is selective; the wider problems being simply presented by omitting much conflicting and difficult detail. The contemporary problem of creep-resistant alloys is treated specially, but in outline only. The bibliograph is brief. A. J. KENNED

539.434 : 548

6516. A surface effect in the creep behaviour polycrystalline lead. E. N. DA C. ANDRADE AN A. J. KENNEDY. Letter in *Proc. Phys. Soc., Lond.* **64**, 363–6 (*April*, 1951).

539.5(

6517. Theory of an instrument for rheological i vestigation by deformation of the material between tw conical rings. T. YA. GORAZDOVSKIĬ. *J. Tech. Phys USSR*, **20**, 1107–10 (*Sept.*, 1951) *In Russian.*

A new principle of construction for an instrume for absolute rheological measurements of easil deformable consistent materials under homogeneou deformation between conical rings is presented Formulae for calculating the elastic modulus i displacement and coefficient of viscosity for material tested are given. B. F. KRAU

539.53

6518. The hardness and strain-hardening of Plasticine G. W. SCOTT BLAIR. *Brit. J. Appl. Phys.*, **2**, 71– (*March*, 1951).

When Plasticine is loaded with a sphere indente at a series of increasing loads, time being allowed fo the indentation virtually to cease, the yield-value increase markedly. Meyer coefficients, while ap parently increasing from values of less than 2·0 a small loads, soon reach a constant high value of abou 3·5 and, except perhaps after very long times when they may increase still further, remain approximately constant. But in such experiments, stress, strain and time are all varying. When stress is maintained constant, the rate of indentation (i.e. increase in projected area of indent) progressively slows down with time; but the Meyer exponent obtained under these conditions is found to be less than 2·0. Contrary to the views of earlier workers, it is concluded that Plasticine does work-harden considerably in most accepted senses of the term, but the definition of "work-hardening" is too vague for a categorical statement to be made. Plasticine also shows a very slow elastic recovery of considerable magnitude. A.

539.62

6519. Erratum: Dry metallic friction as a function of temperature between 4·2°K and 600°K. I. ŠIMON, H. O. MCMAHON AND R. J. BOWEN. Letter in *J. Appl. Phys.*, **22**, 848 (*June*, 1951).

See Abstr. 3107 (1951). Acknowledgment of prior publications.

539.621 : 537.221

6520. Dry friction and electric contact at small displacements. A. E. SALOMONOVICH. *J. Exp. Theor. Phys., USSR*, **20**, 647–60 (*July*, 1950) *In Russian.*

Existence of a domain of preliminary tangential displacements of solids established where ordinary dry friction forces occur and interaction between contact surfaces has near-conservative character; it extends, depending on conditions, to displacements $\sim 2\times10^{-7}$ to 1×10^{-6} cm. Measurement of average contact resistance under contact vibration shows increasing resistance above 5×10^{-8} cm amplitude. Up to 5×10^{-7} to 5×10^{-6} cm this increase is regular

and reversible. The character of the near-conservative forces is cubic, and thus slipping occurs under external force exceeding the maximum interaction force. Similar forces are also set up under normal displacements. Contrasting with those at tangential displacements, the forces have here no symmetrical character, because in addition to the cubic term there is a quadratic term. At small periodic displacements (5×10^{-8} to 5×10^{-6} cm), whether normal or tangential, a detector action of the contact occurs when it carries current, and the frequency may be the same as or double the displacement frequency. B. F. KRAUS

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.115

6521. The correlation of thermochemical data by the ionic potential. G. H. CARTLEDGE. *J. Phys. Coll. Chem.*, **55**, 248–56 (*Feb.*, 1951).

It has been shown that the heats of formation of many compounds may be quantitatively correlated by use of the ionic potentials of the electropositive constituents. A.

541.115

6522. Interpretation of the data on the thermal decomposition of nitrous oxide. H. S. JOHNSTON. *J. Chem. Phys.*, **19**, 663–7 (*June*, 1951).

The data, which as they stand are anomalous in many respects, are examined. It is found at low concentrations of N_2O that a heterogeneous first-order reaction of low energy of activation becomes important. Correction of all data for this heterogeneous reaction removes most of the anomalous spread of values of the energy of activation which had varied from 48 to 65 kcal/mole. The energy of activation at the low concentration limit is 59 kcal/mole, which gives normal pre-exponential factors and "number of oscillators." The data, corrected for heterogeneity, are those for a straightforward unimolecular reaction, giving the low concentration limit and approaching the high concentration limit. By empirical modification of existing theories specific rate constants are found for the variously excited molecules which give a good description of the observed curve of log rate-constant *v.* log concentration. The function of specific rate constants *v.* energy of the molecule is closely related to the continuous form proposed by Rice and Ramsperger, who assume four effective oscillators, which is the number of normal modes of vibration of the N_2O molecule. More experimental work is needed on this kinetic system. A.

541.124 : 541.57

6523. The influence of conjugation on heterolytic dissociation energies. H. C. LONGUET-HIGGINS. *Proc. Roy. Soc. A*, **207**, (*June* 7) 121–33 (1951).

This paper is concerned with reactions of the type $X:Y = X:+Y$, where X or Y is a conjugated system. It is shown that the effect of substitution in X or Y on the energy of such a reaction may be calculated very simply by a combination of molecular orbital theory and first-order perturbation theory. The theory is applied to recent data on the ionization constants of heteroaromatic amines, with encouraging results. It is also possible to account for the observed reactivity of methyl groups at particular positions in heteroaromatic molecules; and predictions are made concerning the reactivity of methyl groups attached to the biphenylene ring system. Finally, examples are given to illustrate the use of the theory in predicting how nuclear substitution will affect the activity of an aromatic system towards electrophilic and nucleophilic reagents. A.

541.127

6524. Source of the light recorded in photographs of detonating explosives. S. PATERSON. Letter in *Nature, Lond.*, **167**, 479–81 (*March* 24, 1951).

High-speed mirror camera records of explosive charges detonated in air and in water demonstrate that most of the light emitted in air arises from a shock-wave generated in the ambient atmosphere. This is suppressed when the charge is surrounded by water. Experiments are described which show that when the air-shock luminosity is eliminated, no appreciable light is emitted by a plastic explosive containing few, if any, air-pockets, but that when air-pockets are artificially introduced, the detonation becomes luminous. Intense light is also emitted when a strong shock passes through a non-reactive granular material containing abundant air-pockets. It is suggested that, after atmospheric shocks have been suppressed, a great part of the residual light from a detonating granular explosive originates in the air-pockets between the explosive grains. If this is so, doubt is cast on estimates of explosive reaction-time based on measurements of the duration of luminosity. A. SCHOFIELD

541.127

6525. Fading of detonation in cones of explosive. D. W. WOODHEAD AND R. WILSON. Letter in *Nature, Lond.*, **167**, 565–6 (*April* 7, 1951).

The point at which steady detonation ceases in a conical charge initiated at the broad end was observed by means of a mirror camera. The limiting dia. for steady propagation increases as the cone-angle decreases; by extrapolation to zero cone-angle the limiting dia. in a cylindrical stick can be found. This technique was applied (in 1944) to a study of the reliability of propagation of detonation in TNT. A, SCHOFIELD

541.127

6526. Detonation of secondary explosives by an electric spark, and remarks on a note by R. Schall on the same subject. JAC. BASSET AND JAS. BASSET. *C.R. Acad. Sci., Paris*, **232**, 1649–51 (*April* 30, 1951) *In French.*

Comparing the experimental arrangement used by Schall [Abstr. 4833 (1951)] with that used earlier by them [*C.R. Acad. Sci., Paris*, **231**, 759 (*Oct.* 16, 1950)], the authors claim that their own technique possesses

the following advantages: (*a*) thin pellets of explosive are used, so that initial rapid deflagration cannot develop into detonation; this means that a simple observation of damage to the tube containing the explosive is sufficient to determine whether detonation took place; (*b*) the electrode design constrains the initiating spark to pass through the centre of the explosive pellet, whereas in Schall's apparatus an alternative route exists over the surface of the pellet.

A. SCHOFIELD

541.127

6527. Kinetics of the thermal decomposition of di-*t*-butyl peroxide. J. Murawski, J. S. Roberts and M. Szwarc. *J. Chem. Phys.*, **19**, 698–704 (*June*, 1951).

541.127.1 : 541.952.6

6528. Methyl radical induced polymerization of gaseous butadiene. D. H. Volman. *J. Chem. Phys.*, **19**, 668–70 (*June*, 1951).

Free methyl radicals from thermally decomposing di-*t*-butyl peroxide were used to initiate the polymerization of gaseous butadiene. The rate of polymerization was found to follow the equation $-d[M]/dt = k_p(k_i/k_t)^{\frac{1}{2}}[M][C]^{\frac{1}{2}}$, where k_p, k_i and k_t refer to the rate constants for propagation, initiation and termination, respectively; M and C refer to butadiene and peroxide. From the effect of temperature on the over-all rate constant and the known values of E_i and E_t, the value of E_p, the activation energy for chain propagation, was found to be 2·6 kcal/mole.

A.

ELECTROCHEMISTRY 541.13

541.132

6529. Theory of ionic association in strong electrolytes, and calculation of the elementary ionic charge. T. Erben. *Istanbul Tek. Üniv. Bül.*, **2** (*No.* 2) 1–16 (1949) *In French.*

Two expressions for the degree of ionic association in strong electrolytes are obtained from the theories of Bjerrum and of Debye–Hückel respectively, and a comparison of these expressions has enabled the estimation of the elementary ionic charge to within 0·8% of the latest experimental value. The theory now developed has also enabled the derivation of a new law of variation of the dielectric constant of water as a function of temperature, with results in accord with experiment. Data are given for 17 uni-univalent (e.g. LiF), 6 uni-bivalent (e.g. Li_2SO_4), and 6 bi-univalent (e.g. $CaCl_2$) electrolytes.

H. H. HODGSON

541.133

6530. The conductivity of concentrated electrolyte systems as a function of temperature and concentration. L. R. Dawson, G. R. Leader and H. K. Zimmerman, Jr. *J. Phys. Coll. Chem.*, **55**, 447–55 (*March*, 1951).

Specific conductances have been measured for concentrated aqueous solutions of organic salts. The data are presented in the form of contour maps which show specific conductivity as a function of temperature and concentration simultaneously. Density and viscosity data are presented for the two aqueous systems also. These data indicate that the conductivity is not controlled entirely by the viscosity of these systems.

A.

541.133

6531. Method for obtaining a sharp meniscus of separation of ions, and determination of their mobilities. J. Lima-de-Faria. *C.R. Acad. Sci., Paris*, **232**, 1670–2 (*April* 30, 1951) *In French.*

A simple experimental procedure is described in detail for obtaining a sharp meniscus in the separation of the ions of $KMnO_4$ and $K_2Cr_2O_7$ in aqueous media, and in horizontal tubes. The method is utilized for the calculation of the ionic mobilities, and the results are satisfactory although not exact.

H. H. HODGSON

541.134 : 539.232

6532. On the electromotive forces in tarnishing reactions. Y. Koi. *J. Sci. Hiroshima Univ.*, **14**, 245–6 (*Sept.*, 1950).

Assuming as characteristic of the tarnishing reaction that only the metal atoms diffuse through the reaction product and that the latter only has an electronic and ionic conductivity when of non-stoichiometric composition, the expression:

$$V = -\frac{2v_i}{v_e - v_i}\,\frac{kT}{e}\log\frac{n_2}{n_1}$$

is derived for the potential V between metal electrodes connected across the specimen. v_i and v_e are the ionic and electronic (or + ve hole) mobilities, n_1 and n_2 are the densities of mobile ions on the electropositive and electronegative sides respectively of the tarnish film, k is Boltmann's constant, T the absolute temp. and e the electronic charge. Application is made to the case of the Cu–O reaction and it is found that even for the most favourable values of n_1 and n_2, which now refer to the number of vacant copper lattice sites, V will be very small and only observable when v_i is not too small compared with v_e.

A. D. LE CLAIRE

541.134 : 539.232

6533. Electromotive force in tarnishing reaction of Cu by S. T. Kushida. *J. Sci. Hiroshima Univ.*, **14**, 247–50 (*Sept.*, 1950).

A simple apparatus is described with which it is observed that when Cu is exposed to S vapour there is set up across the Cu_2S layer formed, an e.m.f. directed towards the Cu and which, for constant temperature T of the Cu, increases with increasing vapour pressure p of the S at first slowly ($p = 0$ to 0·3 mm Hg), then more rapidly ($p = 0{\cdot}3$ to 50 mm Hg) and then progressively more slowly until at about $p = 100$ mm Hg (for the two values of T studied) it reaches a max. For all p the e.m.f. increases with increasing T. At $T = 490°C$, max. e.m.f. = 40 mV and at 540°C = 50 mV. These results are discussed in the light of Koi's theory of the e.m.f. (see preceding Abstr.). The author's previous unpublished work shows that the density of vacant Cu sites $n_2 =$ const. $p^{1/n}$, where $n = 8$ for $p > 0{\cdot}3$ mm Hg and $n = 20 \sim 40$ for $p < 0{\cdot}3$ mm Hg, and when this value of n_2 is inserted in Koi's equation, with n_1 assumed constant, qualitative agreement is obtained with all the experimental observations save that of

the progressively more slow rate of increase of e.m.f. at p above 50 mm Hg. Quantitative comparison of theory with experiment is impossible in the absence of measurements of v_i and v_e. A. D. LE CLAIRE

541.135.5

6534. Theory of electrolytic polishing. M. HALFAWY. Letter in *Experientia*, 7 (*No.* 7) 175–6 (1951).

From a systematic study of electrolytic polishing of Cu in phosphoric acid, the coefficient of relative viscosity of the anode diffusion layer was found to be almost 30 (water = 1), and this high viscosity causes a damping down of anionic velocity. The net result is a preferential accumulation of phosphate ions at the projections, and thus a relatively high probability of Cu ions being detached from the lattice and going into solution. The dissolution of the projections results in a levelling effect eventually leading to a highly polished surface. H. H. HODGSON

541.135.5

6535. Overvoltage in the cerous-ceric oxidation-reduction system. E. LEWARTOWICZ. *C.R. Acad. Sci., Paris*, **232**, 1756–8 (*May* 7, 1951) *In French.*

Application of R. Audubert's theory of overvoltage [*J. Phys. Rad.*, 8^e (*Sér*) **3**, 81–9 (1942)] to the equilibrium $Ce^{+3} \rightleftharpoons Ce^{+4} + \theta$ enables the determination of transfer coefficients and of energies of activation. The advantages are discussed of utilizing a reversible oxidation-reduction electrode as reference electrode. H. H. HODGSON

541.135.5

6536. Variations of concentration at electrodes during electrolysis. D. ROLLET AND L.-H. COLLET. *C.R. Acad. Sci., Paris*, **232**, 1760–2 (*May* 7, 1951) *In French.*

From variations in electrode concentration during the electrolysis of hydrochloric acid between Pt electrodes, it is found that hydration of the ions may counteract their difference in speed and become the predominant effect in dilute solution. H. H. HODGSON

541.135.6

6537. Overvoltage at the copper electrode. T. RUBIN. Letter in *J. Chem. Phys.*, **19**, 803 (*June*, 1951).

Overvoltage is associated with a space-charge-controlled diffusion process in a fixed layer of a cuprous salt on the electrode which has semiconducting properties, or a similar process, involving ions in a thin layer of solution containing cuprous ion next to the electrode which is controlled by space charge. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15 : 539.16.08

6538. A colorimetric dosimeter for qualitative measurement of penetrating radiations. G. V. TAPLIN AND C. H. DOUGLAS. *Radiology*, **56**, 577–91 (*April*, 1951).

The liberation of acid from chloroform is used to change the colour of an indicator (Bromcresol purple) after a dose of radiation depending on the initial pH of the system. Sealed Pyrex tubes are made up to change colour at doses of 200, 400 and 600 r, and a detailed study is given of their stability, temp.-dependence, etc. The sensitivity varies greatly with γ-ray wavelength, and an average calibration is taken; very high accuracy is not claimed. F. T. FARMER

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.183

6539. The assumptions of the B.E.T. theory. W. G. MCMILLAN AND E. TELLER. *J. Phys. Coll. Chem.*, **55**, 17–20 (*Jan.*, 1951).

An isotherm equation, valid in the region of multilayer adsorption, is obtained which takes account both of the effect of the surface energy of the adsorbate and of the extension of the adsorbent attractive forces beyond the first layer. The differences between this equation and one of identical function form obtained earlier by Hill are usually negligible numerically, but the present treatment supplies the quantitative evaluation necessary for a justification of Hill's model. A.

541.183

6540. Phase transitions of argon adsorbed on graphite. G. JURA AND D. CRIDDLE. *J. Phys. Coll. Chem.*, **55**, 163–72 (*Feb.*, 1951).

Four 1st-order phase changes were found at 65°K. A possible explanation for the number may be that the surface is heterogeneous or that the adsorbed film undergoes polymorphic transitions. The adsorption is sigmoid even at surface coverages less than that required for a monolayer. A few of the possible thermodynamic quantities of interest obtainable from the data are presented. A.

541.183

6541. The sorption of gases on metals at room temperature. A. L. MCCLELLAN AND N. HACKERMAN. *J. Phys. Coll. Chem.*, **55**, 374–83 (*March*, 1951).

Isotherms for the sorption of O, Cl, NO and NO_2 at 30°c on unreduced and reduced surfaces of steel, stainless steel and pure Cr powders have been determined by the use of a quartz-spiral spring balance. In general, each of the gases was picked up by the metals in the following decreasing order: steel, stainless steel, Cr. Reduction by H treatment increased the uptake of both O and Cl on steel but made very little difference with the passive metals. There was no firm evidence of physical adsorption. A.

541.183

6542. Adsorption of water vapour on solid surfaces. F. P. BOWDEN AND W. R. THROSSELL. Letter in *Nature, Lond.*, **167**, 601 (*April* 14, 1951).

Measurements (by a microbalance and by light polarization) show that the thickness of the adsorbed film of water vapour on clean surfaces of metal, of diamond and of zinc blende, does not exceed a very few molecular layers even at saturation; larger adsorptions are ascribed to a trace of hygroscopic impurity. S. J. GREGG

541.183

6543. Theory of sorption columns. E. Glueckauf; J. F. Duncan and E. Glueckauf; E. Ekedahl, E. Högfeldt and L. G. Sillén. Letters in *Nature, Lond.*, **167**, 713–16 (*May* 5, 1951).

In the first two communications criticism is expressed of certain statements contained in recently published papers of the authors of the last communication, in which an answer to the criticism is given. F. LACHMAN

541.183 : 536.421.1

6544. Effect of the adsorption of gases on the fusion of crystallized bodies. H. Forestier and J. Maurer. *C.R. Acad. Sci., Paris*, **232**, 1664–6 (*April* 30, 1951) *In French.*

Presents in the form of graphs the results of investigation on the melting points of LiCl, KNO_3, Bi, Pb and Sn, when melted in one of the following gases: He, H, Ne, N, A, CO_2. It has been found that (1) the melting point of each substance varies from one gas to another, (2) for the same substance, the lowering of the melting-point is an increasing function of the boiling point of the gas used (or of the percentage of the adsorbed gas). F. LACHMAN

541.183 : 541.124

6545. Effect of the adsorption of gases on the rate of reduction of nickel[ous] oxide by tungsten. J.-P. Kiehl. *C.R. Acad. Paris*, **232**, 1666–8 (*April* 30, 1951) *In French.*

The rate of reduction of NiO by W, as well as the temperature of transformation of W_α into W_β, are influenced by the nature of the gas present (He, Ne, A, N, CO_2). This effect is connected with the adsorption of gases, and disappears at a higher temperature. F. LACHMAN

541.183.5

6546. Absolute adsorption isothermals of vapours on quartz and silica gels of various structures. N. N. Avgul, O. M. Dzhigit, V. P. Dreving, M. V. Gurev, A. V. Kiselev and O. A. Likhacheva. *Dokl. Acad. Nauk, SSSR*, **77** (*No.* 1) 77–80 (1951) *In Russian.*

CHEMICAL STRUCTURE 541.4/.6

541.57

6547. Calculation of the intensity of interaction in π bonds. S. Senent and M. Aguilar. *An. Real Soc. Esp. Fis. y Quim.*, **46**, 323–8 (*Nov.–Dec.*, 1950) *In Spanish.*

The formation of the bindings in a multiplex is discussed and an original method is proposed for calculating the intensity of interaction in a π bond, based upon the determination of orientation and distance of overlapping of the orbitals by which it is formed so that there will be a maximum intensity of interaction. A.

541.57 : 541.115

6548. Experimental methods for measurement of bond dissociation energies and heats of formation of radicals. M. Szwarc. *Proc. Roy. Soc. A*, **207**, 5–13 (*June* 7, 1951).

Describes a pyrolytic method of investigating the kinetics of gaseous reactions in which toluene is used as a carrier gas. It is shown that the method is particularly suitable for the determination of bond dissociation energies. The scope is illustrated by examples. A list of bond dissociation energies obtained is given. The manner in which the experimental results can be cross-checked is indicated. The effects of various constitutional factors on the bond dissociation energies are discussed. A.

541.64

6549. Physics of rubber-like materials. L. R. G. Treloar. *Nature, Lond.*, **167**, 425–7 (*March* 17, 1951).

Summary of four lectures on the chain network theory. J. E. CAFFYN

541.64

6550. Nuclear magnetic resonance study of transitions in polymers. L. V. Holroyd, R. S. Codrington, B. A. Mrowca and E. Guth. *J. Appl. Phys.*, **22**, 696–705 (*June*, 1951).

Nuclear magnetic resonance absorption line widths have been studied for several high polymers. The proton line widths were studied in a field of 7 000 gauss and at a frequency of about 30 Mc/s. Line widths obtained for Hevea and GR-S were very narrow, indicating a large degree of "quasi-free rotation" in these materials. Vulcanization, carbon loading, co-polymerization and crystallization produced a broadening of the lines as expected from the hindrance to internal motion introduced by these factors. Line width transitions as a function of temperature were observed for several polymers. Linear thermal expansion coefficients and specific heat *v.* temperature curves have breaks in the region of line transitions for the polymers studied. Swelling of polymers with benzene produced a narrowing of the absorption line throughout the line transition and lowered the transition temperature. Vulcanization broadened the transition range and shifted it to higher temperatures. Of two closely cut fractions of polystyrene, the larger molecular weight sample exhibited a line transition range at a higher temperature. The styrene monomer as well as the two fractions exhibited the same low-temperature line width of about 8 gauss. The line-width transitions were also studied for three butadiene styrene co-polymers at temperatures where anomalous behaviour was found in dynamic measurements. The theoretical implications of these experimental results, together with a survey of other pertinent work, indicate the possibilities of the nuclear resonance method as applied to the study of high polymers in conjunction with other methods. A.

541.65

6551. Molecular compounds of the quinhydrone type. H. Murakami. *Sci. Pap. Osaka Univ., No.* 18, 18 *pp.* (1949).

Absorption spectral evidence for the structure of molecular compounds of the quinone group in solution is given. W. R. ANGUS

CHEMICAL ANALYSIS 543/545

545.372

6552. Influence of the frequency of the applied voltage at a mercury dropping electrode. Study of the polarographic curves. M. FOURNIER. *C.R. Acad. Sci., Paris*, **232**, 1673–4 (*April* 30, 1951) *In French.*

From a study of the polarographic method by means of the cathodic oscillograph, it is found that the superposition of an alternating current on the continuous current of the classical polarographic procedure, does not modify the limiting diffusion current nor the half-wave potential of monovalent ions, but renders the half-wave potential of the majority of divalent ions more electropositive.

H. H. HODGSON

545.822

6553. Studies on quantitative emission spectrum analysis. I. Influences of deviation on the supply electric-potential and cycle and one ellipsis of the standard samples. S. MUSHA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 36–8 (*Feb.*, 1950).

Describes expts. on the effect of varying different parameters (e.g. circuit constants) on the accuracy of spectroanalysis of metals. J. D. CRAGGS

545.822

6554. Studies on quantitative emission spectrum analysis. II. Determination of beryllium by liquid-condensed-sparking method. S. MUSHA. *Sci. Rep. Res. Inst. Tôhoku Univ., Ser. A*, **2**, 39–42 (*Feb.*, 1950).

Describes a spectroscopic technique for the analysis of Be in Al, Cu, etc. Representative results are given in tabular form. J. D. CRAGGS

545.822

6555. Suppression of line intensities by perchloric acid. E. E. PICKET AND G. TODD. Letter in *J. Opt. Soc. Amer.*, **41**, 361 (*May*, 1951).

If perchloric acid is used in preparing biological samples for spectrographic analysis it is essential to remove the acid by baking at 500°C. Otherwise suppression of line intensities will occur, leading to false estimates of the concentration of the various metals present. Use of an internal standard, e.g. nickel chloride, does not correct for this suppression. A table showing typical results is given. J. IBALL

545.822

6556. Spectrographic determination of halogens and sulfur in engine deposits. W. O. MANSFIELD, JR., J. C. FUHRMEISTER AND D. L. FRY. *J. Opt. Soc. Amer.*, **41**, 412–16 (*June*, 1951).

CRYSTALLOGRAPHY 548

548.0 : 535.323

6557. Refractive indices of rutile and sphalerite. J. R. DEVORE. *J. Opt. Soc. Amer.*, **41**, 416–19 (*June*, 1951).

Prisms were made from single crystals of rutile and sphalerite and used in measuring the refractive indices of these materials. The measurements were made through the visible spectrum and extended to 1·5 microns in the infrared by the use of an infrared sensitive screen. The dispersion curves and the equations for the curves were determined. Values taken from the curves were found to agree moderately well with published values. The results demonstrate the high dispersion and the large birefringence of rutile. The experimental results also demonstrate the strong absorption of rutile in the violet end of the visible spectrum which accounts for its slight yellow colour. A.

548.0 : 535.66 : 537.531

6558. A study of color centers produced in quartz by X-radiation. G. FORMAN. *J. Opt. Soc. Amer.*, **41**, 377–80 (*June*, 1951).

Z-cut sections of natural quartz crystals were coloured to saturation by X-irradiation from a Be window X-ray tube. The crystal sections were decoloured by heating and recoloured by further X-radiation. The same optical transmissions, at saturation, were obtained when the energy distribution of the X-ray beam was the same but were different when different voltages were applied to the X-ray tube. The heat treatment used in removing the colour from quartz does not affect the value of the optical transmission when recoloured by X-radiation to saturation. It was observed that in every case the rate of colouration was greater after the section had been cleared and re-irradiated than when the colour was being produced for the first time. If the heat treatment is restricted to an amount barely sufficient to remove the colouration, then the rate follows the same curve on successive irradiation cycles. If the crystal section is baked for a longer period of time than that stated above, the rate decreases and approaches that of fresh quartz. The change in rate of colouration of quartz is governed by the immediately preceding heat treatment employed in removing the colour centres. No "memory" of previous heat treatments appears to be present. A.

548.0 : 535.662

6559. Colour of beryl. B. MUKHERJEE. Letter in *Nature, Lond.*, **167**, 602 (*April* 14, 1951).

548.5

6560. The growth of crystals and the equilibrium structure of their surfaces. W. K. BURTON, N. CABRERA AND F. C. FRANK. *Philos. Trans A*, **243** (*No.* 866) 299–358 (1951).

The rate of advance of monomolecular steps is calculated as a function of the supersaturation in the vapour and the mean concentration of kinks in the step, and the effect due to curvature of the step considered. The growth rate and steepness of growth cones are obtained, when steps persist owing to dislocations; the behaviour of systems of dislocations are analysed. Expressions for the growth of surfaces containing dislocations are deduced. The theory is also applied to growth from solution. The activation energy for 2-dimensional nucleation is derived from considerations of the equilibrium structure of steps;

it is found to be too large to account for the growth of real crystals under moderate supersaturations. The temperature dependence of the surface structure of a perfect crystal is treated as a co-operative phenomenon; the transition temperature from a smooth to a rough surface is obtained using Onsager's and Bethe's methods. J. A. FRANKS

548.5 : 539.27

6561. The observation of spiral growth-steps in *n*-paraffin single crystals in the electron microscope. I. M. DAWSON AND V. VAND. *Proc. Roy. Soc. A*, **206**, 555–62 (*May* 22, 1951).

See also Abstr. 4790 (1951). Electron micrographs of single crystals of the *n*-paraffin, *n*-hexatriacontane, $C_{36}H_{74}$, show clearly the successive monomolecular steps on the growing face of the crystal. Examination of the edge of these molecular steps shows, in many crystals, not a succession of closed terraces, but a continuous spiral on the crystal face. The results thus afford direct visual confirmation of the theory of crystal growth by spiral growth-steps ending on screw dislocations. There is no evidence of the long-range migration of molecules over the growing face of the crystals. The molecules appear to condense only on the developing edge. A.

548.538

6562. New observations of epitaxial grouping between different kinds of crystals. L. ROYER. *C.R. Acad. Sci., Paris*, **232**, 1764–6 (*May* 1, 1951) *In French.*

Oriented crystals of α-hydroquinone and anthraquinone were grown from solution on (001) faces of NaCl and LiF. No orientation occurred with NaCl grown on LiF; this is explained by considering the ionic structure of the crystals. Orientation of anthraquinone was also observed on the (001) faces of brucite and muscovite. J. A. FRANKS

548.538

6563. The epitaxy of alkali chlorides on metals. G. W. JOHNSON. *J. Appl. Phys.*, **22**, 797–805 (*June*, 1951).

The alkali chlorides were crystallized from solution on single crystals and on polycrystalline specimens of various metals. Oriented growth was obtained on Ag, Au, Cu, Zn, Pb, Sb, Bi and Fe. Since oxide films were present on all metals except Ag and Au, it was concluded that the oxides were oriented with respect to the metallic substrate. From results with Ag and Au, it was found that the permissible misfit for epitaxy to occur was of the same order (~ 10%) as for ionic pairs.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

6564. Dislocations in real crystals. B. CHALMERS AND U. MARTIUS. Letter in *Nature, Lond.*, **167**, 681–2 (*April* 28, 1951).

Taking $\tan \beta = s/a$ where s is the interatomic spacing in the direction of the Burgers' vector, and a the interplanar spacing parallel to a selected plane, the appropriate values of β have been calculated for all the more probable dislocations in the f.c.c., b.c.c., c.p.h. and b.c. tetragonal lattices. In all cases the Burgers' vector and the selected plane corresponding to the minimum β (i.e. the most likely dislocations) are identical with the observed slip direction and slip plane respectively. Whether edge- or screw-type dislocations are responsible cannot be determined without other energy considerations. A. J. KENNEDY

548.7

6565. Lattice vibrations and optical waves in ionic crystals. K. HUANG. Letter in *Nature, Lond.*, **167**, 779–80 (*May* 12, 1951).

For diatomic crystals with optical isotropy an explicit solution for the retardation effect is given. Some optical waves in crystal optics are found to be identical with transverse lattice vibrations in the theory of ionic crystals. C. TURNER

548.7 : 512.83

6566. A new viewpoint in computing crystal frequencies. W. A. NIERENBERG. Letter in *J. Chem. Phys.*, **19**, 659 (*May*, 1951).

The distribution of frequencies is obtained in terms of the eigenvalues of the infinite matrix governing the motions of the atoms. An example is given.

A. R. STOKES

548.7 : 536.424

6567. Phase transition in NaCN and KCN. T. MATSUHARA AND T. NAGAMIYA. *Sci. Pap. Osaka Univ., No.* 14, 17 *pp.* (1949).

The interaction potentials between a CN^- and an Na^+ or K^+ and between two CN^- were determined and the hindering potential for the rotation of any CN^- in the lattice in the high and the low temperature forms calculated. The free energies (A and B) of these forms were derived using these values together with the lattice energies, and adjusting to give the experimental transition temperature. The calculated difference of A and B at absolute zero differs from the observed values by 0·35% (NaCN) and 0·6% (KCN) of the total lattice energy. Reasons for these deviations are discussed. A. J. KENNEDY

548.7 : 536.653

6568. On the ageing of KCl–KBr mixed crystals. V. HOVI. *Suom. Kem.*, **23** (*No.* 3–4) 5 *pp.* (1950).

The energy content of solid solutions is diminished by $\Delta Q = \frac{1}{8}\sigma Q_I \Theta$ when a degree of local order σ develops, where Q_I is the electrostatic part of the heat of formation and Θ depends on the composition of the solution. The heat of formation Q is measured experimentally as the difference between the heat of solution in water of the solid solution, and the heat of solution of a mechanical mixture of the same gross composition. For K_2BrCl crystals annealed for 200 hours at 600°C, quenched, and dissolved immediately Q is 241 cal/mol, but on ageing it decreases gradually, reaching 234 cal/mol after some months. The rate of decrease is connected with the duration of annealing at 600°C, corresponding values for 310 hours being 247 and 231 cal/mol. From the X-ray evidence ΔQ is calculated for various compositions, and compared with experiment.

A. J. C. WILSON

548.7 : 548.5

6569. Dislocations as lattice properties and their significance for the plasticity and growth of crystals. I. A. KOCHENDÖRFER. *Phys. Bl.*, **7** (*No.* 4) 151–62 (1951) *In German.*

A description is given of the dislocations in crystals, and their importance in glide phenomena is discussed. A qualitative account is given of the behaviour of the dislocations (edge and screw) under the action of externally applied forces. J. A. FRANKS

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 6497–502

548.732

6570. Calculation of the intensity of diffuse scattering of X-rays for ageing alloys. YU. A. BAGARYATSKIĬ. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 1) 45–8 (1951) *In Russian.*

The problem is considered in 1 dimension. A foreign atom occurs (perhaps also displaced) at irregular intervals in a regular chain. The scattered intensity is made up of 3 terms, due to the regular array of atoms, due to the errors only and the cross term. Of these only the second has a value at points other than reciprocal lattice points. Following Méring [Abstr. 6159 (1950)] the diffuse scattering is calculated for a Gaussian distribution of the distances between errors. From published data the diffuse scattering in Al–Cu alloys is drawn out for 3 different degrees of segregation. A. L. MACKAY

548.733 : 537.531

An X-ray micro-beam technique. *See Abstr.* 6251–2

548.734.3

6571. Diffraction spots on X-ray back-reflection photographs. G. FROHNMEYER AND R. GLOCKER. *Naturwissenschaften*, **38** (*No.* 7) 155–6 (1951) *In German.*

Back-reflection photographs of coarse-grained metals were taken using a double-crystal monochromator. The spots are all found to lie on Debye–Scherrer lines. See Bragg and Lipson, *Nature, Lond.*, **141**, 367 (1938). A. R. STOKES

548.734.3

6572. Absorption edges on Debye–Scherrer X-ray photographs. R. BROOKS. *Brit. J. Appl. Phys.*, **2**, 76–7 (*March*, 1951).

On powder photographs taken with $K\alpha$ radiation obtained by filtering X-rays from a pure metal target through the appropriate "β-filter," sharp-edged bands which are not normal powder lines, may occur in the low-angle region. These are shown to be due to residual X-rays of short wavelength which give rise to dark bands where fluorescence of silver and bromine occurs in the photographic emulsion. It is concluded that in the analysis of mixtures it should be borne in mind that bands of this sort accompany all strong $K\alpha$ reflections from the specimen, and they should be carefully distinguished from weak $K\alpha$ reflections. A.

548.734.3

6573. New approaches to the interpretation of X-ray powder photographs. H. LIPSON AND H. STEEPLE. Letter in *Nature, Lond.*, **167**, 481 (*March* 24, 1951).

"Spottiness" in photographs, due to large grain-size in specimens, can be used to help to index diffraction lines. A. R. STOKES

548.734.34

6574. A modification of the Cohen procedure for computing precision lattice constants from powder data. J. B. HESS. *Acta Cryst.*, **4**, 209–15 (*May*, 1951).

The Cohen scheme for weighting the measurements upon the lines of powder patterns is shown to be inappropriate, and a modified weighting is proposed. Examples are given to illustrate the improvement in precision resulting from the modified method. A.

548.734.4

6575. On the Lorentz factor for rotating-crystal [X-ray] photographs. H. G. HEIDE. *Ann. Phys., Lpz.*, **8** (*No.* 5–8) 240–5 (1951) *In German.*

See Abstr. 2170 (1951). Expressions are obtained which take into account the finite width of diffraction maxima due to mosaic crystal structure and other causes. A. R. STOKES

548.734.842

6576. A photoelectric structure-factor machine. M. M. WOOLFSON. *Acta Cryst.*, **4**, 250–3 (*May*, 1951).

Lipson and Taylor have described a photoelectric device using Huggins' masks from which structure factors were derived with correct signs, but with some large errors in magnitude. The present paper describes an investigation of these errors (which has shown that they can be ascribed to imperfections in the masks) and the preparation of more accurate masks and the construction of a more versatile machine. The sinusoidal distribution of transmitted intensity is obtained in the new masks by an appropriate arrangement of clear and opaque spots, and since no intermediate tones are involved a detailed knowledge of the characteristics of the photographic emulsions and developers concerned is not required. Each atom is represented by one photocell with its output modified by a potentiometer to allow for the atomic number. An enlarged image of each mask in turn is projected on to this arrangement of cells and the total potential developed is measured by a galvanometer. A.

548.734.842

6577. Forbidden reflections in the Harker–Kasper inequalities. B. S. MAGDOFF. *Acta Cryst.*, **4**, 268–9 (*May*, 1951).

Two variations of the standard method of sign determination, using the Harker–Kasper inequalities, are discussed with specific illustrations from the structure of *p*-di-tertiary-butylbenzene. The first instance is the use in the left-hand side of the inequality of planes whose intensities are zero, owing to space-group extinctions. The second, more interesting, instance involves half odd-integer planes in the same position. A.

548.735

6578. Tables for conversion of X-ray diffraction angles to interplanar spacing. H. E. SWANSON. *Nat. Bur. Stand., Appl. Mat. Ser., No.* 10, 159 *pp.* (1950).

Spacings in A to 5 significant figures are given for θ between 0° and 90° in steps of 0·01° for the K_{α_1} radiations of Mo, Cu, Ni, Co, Fe and Cr, and also for 2θ between 0° and 180° in steps of 0·02° for the K_{α_1} radiations of Cu and Fe only. A. J. C. WILSON

548.735.42

6579. Optical methods in X-ray analysis. I. The study of imperfect structures. C. A. TAYLOR, R. M. HINDE AND H. LIPSON. *Acta Cryst.*, **4**, 261–6 (*May*, 1951).

The correspondence between the diffraction of X-rays by crystals and of light by gratings can be used to test hypotheses put forward to explain the X-ray diffraction patterns of imperfect structures. Two-dimensional gratings of holes in cardboard are made and their diffraction patterns observed in a specially constructed large spectrometer (the Bragg X-ray microscope). Illustrations are given of the application of the method to (*a*) the transition from the cubic to the hexagonal close-packed structure, and (*b*) the ordering process in the alloy $AuCu_3$. From the latter investigation it would appear that the X-ray diffraction effects observed can be accounted for entirely by changes in the degree of short-range order. Some rules are given for guidance in the interpretation of the X-ray diffraction patterns of imperfect structures. A.

548.736.1

6580. The structure of graphitic carbons. R. E. FRANKLIN. *Acta Cryst.*, **4**, 253–61 (*May*, 1951).

The structure of the graphitic carbons is intermediate between the three-dimensional crystalline structure of graphite and the "random layer structure" of the non-graphitic carbons. In the graphitic carbons the graphite-like layers are grouped in parallel packets within which there is a random distribution of orientated and disorientated layers. The inter-layer spacing in the non-graphitic carbons is constant at 3·44 Å and in graphite it is constant at 3·354 Å. In the graphitic carbons the apparent inter-layer spacing decreases with increasing graphitization. But the apparent inter-layer spacing is in reality a mean value. Whatever the degree of graphitization, the small groups of orientated and disorientated layers within the parallel-layer packet retain, in the main, the spacings characteristic of graphite and the non-graphitic carbons respectively. Only among the first disorientation spacings on either side of a group of orientated layers is there a spacing of some intermediate value. A.

548.736.3

6581. X-ray studies on KCl–RbCl mixed crystals prepared from aqueous solution. V. HOVI. *Suom. Kem.*, **23** (*No.* 11–12) 7 *pp.* (1950).

See Abstr. 4280 (1949). (K, Rb)Cl crystals containing 64·48 mol % KCl were obtained by crystallization from solution at 25·54° ± 0·04°C in a specially constructed thermostat. The lattice parameter, 6·398 *k*X, was determined from powder photographs, and agrees well with that for crystals of the same composition obtained from rapidly solidified melts. [The lattice-parameter curve given for these appears to lie about 0·009 lower.] Some parameters for solidified melts are: KCl 6·280 *k*X, 83·14 mol % KCl 6·342, 66·05% KCl 6·382, 49·90% KCl 6·426, 34·22% KCl 6·486, 16·88% KCl 6·534, RbCl 6·568. A. J. C. WILSON

548.736.3

6582. The crystal structure and chemical formula of the titanium oxide Ti_3O_5 (anosovite). A. A. RUSAKOV AND G. S. ZHDANOV. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 3) 411–14 (1951) *In Russian.*

The exact chemical composition of this material and its exact density (approx. density 4·19) were not known but were established by the structural analysis. Small dark blue/black crystals with a metallic sheen were made synthetically of composition between Ti_2O_3 and TiO_2. X-ray measurements showed them to be orthorhombic with $a = 3·747$, $b = 9·465$ and $c = 9·715$ Å. The possible space-groups were $Cmcm$ (D_{2h}^{17}), $C2cm$ (C_{2v}^{12}) or $Cmc2$ (C_{2v}^{16}). From packing considerations and by comparison with anatase ($a = 3·73$) the contents were determined as 4 units of Ti_3O_5. Patterson and Fourier syntheses established the atomic co-ordinates which were confirmed by the satisfactory agreement of observed and calculated structure factors. The atomic parameters are: 4 Ti_I, (0, 0·195, ¼); 8 Ti_{II}, (0, 0·132, 0·561); 4 O_I, (0, 0·777, ¼); 8 O_{II}, (0, 0·043, 0·116); 8 O_{III}, (0, 0·304, 0·062). Examination of bond distances and comparison of powder photographs show the structure to be similar to that of pseudo-brookite $Fe_2O_3 . TiO_2$. TiO_6 octahedra, joined by their vertices, form chains parallel to the *c*-axis. O and Ti atoms are distributed in planes at $x = 0$ and ½. A. L. MACKAY

548.736.3

6583. The crystal structures of molybdenum trifluoride, MoF_3, and tantalum trifluoride, TaF_3. V. GUTMANN AND K. H. JACK. *Acta Cryst.*, **4**, 244–6 (*May*, 1951).

548.736.3

6584. The crystal structure of vanadium trifluoride, VF_3. K. H. JACK AND V. GUTMANN. *Acta Cryst.*, **4**, 246–9 (*May*, 1951).

548.736.3

6585. On the phase transition in tungsten trioxide. R. UEDA AND T. ICHINOKAWA. Letter in *Phys. Rev.*, **82**, 563 (*May* 15, 1951).

An X-ray study of the transition from orthorhombic to tetragonal between 700°C and 750°C. Lattice constants are given. A. R. STOKES

548.736.4

6586. Modifications of bismuthyl nitrate, $BiONO_3 . H_2O$. J. OZOLS. *Latv. PSR Zin. Akad. Vēst., No.* 5, 83–9 (1950) *In Latvian.*

I. Monoclinic prismatic, $a = 18·30$, $b = 16·99$, $c = 9·05$ Å, $\beta = 119° 53' \pm 15'$, density = 4·95 at 25°C, $Z = 24$. II. Hexagonal, $a = 15·54 \pm 1$, $c = 7·63 \pm 1$, density = 4·73 at 25°C, $Z = 15$. A. J. C. WILSON

548.736.4

6587. Malachite: re-examination of crystal structure. A. F. WELLS. *Acta Cryst.*, **4**, 200–4 (*May*, 1951).

548.736.4

6588. The crystal structure of $NaAlCl_4$. N. C. BAENZIGER. *Acta Cryst.*, **4**, 216–19 (*May*, 1951).

The crystal structure of $NaAlCl_4$ has been determined with data obtained from Weissenberg diagrams. The space group is $P2_12_12_1$, and the unit-cell dimensions are $a = 10{\cdot}36$, $b = 9{\cdot}92$, $c = 6{\cdot}21$ Å. With 4 molecules per unit cell, the calculated density is $2{\cdot}00$ g.cm^{-3}. The co-ordinates of the atoms were found from electron-density projections on (100), (010) and (001). The structure consists of Na^+ and $AlCl_4^-$ ions. Interatomic distances from ion to ion are normal, but the Al–Cl ($2{\cdot}13$ Å) and the Cl–Cl ($3{\cdot}48$ Å) distances in the $AlCl_4^-$ tetrahedra are shorter than the normal distances. A.

548.736.4

6589. Crystal chemical studies of the 5*f*-series of elements. XIV. Oxyfluorides, *X*OF. W. H. ZACHARIASEN. *Acta Cryst.*, **4**, 231–6 (*May*, 1951).

548.736.4

6590. Crystal structure of $HNO_3 . H_2O$. V. LUZZATI. *Acta Cryst.*, **4**, 239–44 (*May*, 1951) *In French.*

548.736.4

6591. The structure of mercuric amidochloride, $HgNH_2Cl$. W. N. LIPSCOMB. *Acta Cryst.*, **4**, 266–8 (*May*, 1951).

548.736.4

6592. Crystal structure of lanthanum and praseodymium ferrites. G. GUIOT-GUILLAIN. *C.R. Acad. Sci., Paris*, **232**, 1832–3 (*May* 16, 1951) *In French.*

X-ray investigation indicates that La and Pr ferrites have a cubic structure of the perovskite type with lattice parameters $3{\cdot}899$ and $3{\cdot}867$ Å respectively [see also Abstr. 6642 (1950)]. E. P. WOHLFARTH

548.736.4

6593. X-ray investigations on $BiNbO_4$, $BiTaO_4$ and $BiSbO_4$. B. AURIVILLIUS. *Ark. Kemi.*, **3**, *Paper* 20, 153–61 (1951).

$BiSbO_4$ is monoclinic, $I2/c$ (or less probably Ic), $a = 5{\cdot}46(4)$, $b = 4{\cdot}88(7)$, $c = 11{\cdot}8(1)$ Å, $\beta = 101{\cdot}0°$, $Z = 4$, 4 Sb in (*a*), 4Bi in (*e*) with $y = 0{\cdot}51(2)$, 80I and 80II in (*f*) with co-ordinates $0{\cdot}23$, $0{\cdot}30$, $0{\cdot}06$ and $0{\cdot}12$, $-0{\cdot}14$, $0{\cdot}15$ respectively. $BiNbO_4$ and $BiTaO_4$ are triclinic with $a = 7{\cdot}7(1)$, $b = 5{\cdot}5(5)$, $c = 7{\cdot}9(7)$ Å $\pm$ 2%, $\alpha = 89°$, $\beta = 77°$, $\gamma = 87°$, $Z = 4$, and $a = 7{\cdot}6(9)$, $b = 5{\cdot}6(0)$, $c = 7{\cdot}7(8)$ Å, $\alpha = 89°$, $\beta = 77°$, $\gamma = 86°$ respectively. All these are closely related to stibiotantalite $SbTaO_4$; the resemblance becomes obvious on referring the triclinic crystals to a *B*-face centred cell.

A. J. C. WILSON

548.736.5

6594. The crystal structure of bandylite, $CuCl_2 . CuB_2O_4 . 4H_2O$. R. L. COLLIN. *Acta Cryst.*, **4**, 204–9 (*May*, 1951).

The crystal structure of bandylite is tetragonal C_{4h}^3–$P4/n$ with one molecule of $CuCl_2 . CuB_2O_4 . 4H_2O$ in a cell of dimensions $a = 6{\cdot}19$ and $c = 5{\cdot}61$ Å. The Cu atoms are surrounded in a square planar configuration by four hydroxyl groups at a distance of $1{\cdot}98$ Å and 2 Cl atoms on a line at right angles to this plane at $2{\cdot}80$ Å These distorted octahedra about Cu are joined together into layers by B atoms that are surrounded tetrahedrally by 4 hydroxyl groups at a distance of $1{\cdot}42$ Å. A.

548.736.5

6595. Crystal structure of valentinite and complex antimony (III) fluorides. A. BYSTRÖM. Letter in *Nature, Lond.*, **167**, 780 (*May* 12, 1951).

Notes on structures of Sb_2O_3, KSb_4F_{13}, $CsSb_2F_7$ and SbF_3. A. R. STOKES

548.737

6596. Crystal structure of piaselenole, piazthole and benzofurazane. V. LUZZATI. *Acta Cryst.*, **4**, 193–200 (*May*, 1951) *In French.*

548.737

6597. The crystal structure of strychnine hydrogen bromide. J. H. ROBERTSON AND C. A. BEEVERS. *Acta Cryst.*, **4**, 270–5 (*May*, 1951).

548.737

6598. The Fourier synthesis of the crystal structure of strychnine sulphate pentahydrate. C. BOKHOVEN, J. C. SCHOONE AND J. M. BIJVOET. *Acta Cryst.*, **4**, 275–80 (*May*, 1951).

Strychnine sulphate pentahydrate is monoclinic with space group $C2$ and cell edges $a = 35{\cdot}85 \pm 0{\cdot}05$, $b = 7{\cdot}56 \pm 0{\cdot}01$, $c = 7{\cdot}84 \pm 0{\cdot}01$ Å; $\beta = 107° 20'$. There are four molecules of strychnine in the unit cell. As the heavy atom lies on the symmetry centre of the [010] projection, the application of the Fourier method for this projection follows the well-known lines developed for the phthalocyanine structure. For the non-centro-symmetrical [001] projection the phase angles, except for their signs, were derived from the intensity comparison of the isomorphous structures of the sulphate and the selenate. A symmetrical Fourier synthesis was made, and from this and the [010] projection the atomic positions were found. The strychnine structure thus derived proved to be concordant with that one of the competing structure formulas which just then was unequivocally accepted by the organic chemists. After suitable refinement, averaged errors amount to $0{\cdot}08$ Å for both projections. A.

548.737

6599. On the crystal structure of thyroxine. N. JOEL AND F. G. CANEPA. Note in *Acta Cryst.*, **4**, 283 (*May* 1951).

548.74

6600. On the structure of the streaks in the Kossel–Möllenstedt electron interference patterns with a convergent beam. II. E. FUES AND E. H. WAGNER. *Z. Naturforsch.*, **6a**, 79–84 (*Feb.*, 1951) *In German.*

Uses the theory given in part I [Abstr. 5929 (1951)] to calculate the course of the streaks. J. THEWLIS

548.74

6601. On the structure of the streaks in the Kossel–Möllenstedt electron interference patterns with a convergent beam. III. E. H. WAGNER. *Z. Naturforsch.*, **6a**, 133–9 (*March*, 1951) *In German.*

Demonstrates how the course of the streaks may

be predicted qualitatively by the use of a simple model. The method is applied to the case of mica which represents a 19-beam problem. J. THEWLIS

548.74

6602. Precise determination of lattice constants by electron diffraction and variations in the lattice constants of very small crystallites. F. W. C. BOSWELL. *Proc. Phys. Soc., Lond. A*, **64**, 465–76 (*May*, 1951).

Previous workers have reported that lattice constants determined by electron diffraction differ from the accepted X-ray values. To examine whether these differences are due to a change in lattice constant with crystal size, the lattice constants of several alkali halides have been determined, by electron diffraction, to a higher accuracy than had previously been attained. The X-ray value of the lattice constant of TlCl was used as a standard reference. The lattice constants of six alkali halides, with crystal sizes > 150 Å, agreed with the X-ray values to within the experimental error of 0·05%. For crystal sizes < 100 Å the lattice constants of the alkali halides were $<$ the X-ray values by an amount dependent on crystal size. For a crystal size of about 30 Å the decrease was approximately 0·5%. Similar determinations on evaporated Au films showed that, for a crystal size of about 20 Å, the decrease in the lattice constant was almost 2%. For a crystal size of 40 Å, the largest obtained, the lattice constant was 0·2% $<$ the X-ray value. Evaporated films of Ag and Bi also were found to have lattice constants $<$ the X-ray values. Previous reports of an increase of the lattice constants of alkali halides with decreasing crystal sizes are therefore in error. Some of the discrepancies noted by previous workers may have resulted from assigning the X-ray value to the lattice spacing of Au films or Au foil used as a standard reference. A.

GEOPHYSICS 55

550.341

6603. Polarisation of the *S*-phase of seismograms. R. STONELEY. *Ann. Geofis.*, **4**, 3–8 (*Jan.*, 1951).

The phenomenon that the *S*-phase of earthquakes recorded at moderate distances (say 80°) appears first as *SH*, and then by some 10–14 sec later as *SV*, is examined. To see whether double refraction can be made responsible for this, a model is considered built up of the transversely isotropic mineral beryl, of which we know the 5 elastic constants. This appears to be an extreme case as the earth is probably much less anisotropic. Then the times needed by *SH*- and *SV*-waves travelling in the surface layer are calculated. The result is that even a 30 km thick layer of anisotropic rock would only account for a time-difference of about 1½ sec. The observed large differences would therefore require the unlikely thickness of 300 km for a beryl layer of such a preferred orientation, and probably of still more for the earth. The author concludes that an explanation of the phenomenon in terms of double refraction appears inadequate. A. BEER

550.341

6604. Seismic velocity as a function of depth and geologic time. L. Y. FAUST. *Geophysics*, **16**, 192–206 (*April*, 1951).

Velocity data are compiled from measurements of nearly 1×10^6 ft of section in 500 well surveys in the United States and Canada. Average velocities for shale and sandstone sections are arranged by depth and geologic age. Deviations from the mean values are attributed to lithologic variations. The variations of velocity with depth and time are studied independently in order to develop a quantitative relationship. It is concluded that the velocity for an average shale and sand section is given by the equation $V = 125 \cdot 3(ZT)^{1/6}$, where V is velocity in ft/sec, Z is depth in ft, and T is age in yrs. Velocities in limestone show less definite evidence of increase with age and depth. A.

550.341

6605. Normal mode propagation in three layered liquid half-space by ray theory. C. B. OFFICER, JR. *Geophysics*, **16**, 207–12 (*April*, 1951).

The fundamental integral for normal mode propagation in a 3-liquid layered half-space is derived by multiple reflections, and the physical significance of the characteristic equation is discussed. A.

550.341

6606. Seismic refraction experiments in the North Atlantic. T. F. GASKELL AND J. C. SWALLOW. Letter in *Nature, Lond.*, **167**, 723–4 (*May* 5, 1951).

550.341.2

6607. Earthquakes and rock creep. H. BENIOFF. *Bull. Seism. Soc. Amer.*, **41**, 31–62 (*Jan.*, 1951).

The observed departure of the elastic characteristics of rocks from a simple elastic theory (which takes the strain proportional to the stress and independent of time) is examined. Seismic consequences are investigated, in particular the possible relationship of this departure to the origin of aftershocks and to the characteristics of earthquake sequences. The creep characteristics of rocks are made responsible and dealt with in detail. A. BEER

550.342

6608. The thermic factor in the generation of microseisms. A. DUE ROJO AND A. GIMENO RIUTORT. *Rev. Geofis.*, **9**, 321–33 (*Oct.–Dec.*, 1950) *In Spanish.*

An attempt to establish the relationship between the amplitude of medium and long period microseisms and local temperature fluctuations. E. M. FOURNIER D'ALBE

550.37

6609. A contribution to the study of the influence of the moon on telluric currents. A. ROMAÑÁ AND J. O. CARDÚS. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 511–12 (1950) *In French.*

A summary of a re-examination of data for 1910–20 in order to separate the lunar and solar influences.

This has been done by converting the times of observation into lunar time and then finding mean values for each lunar hour; 3 536 lunar days were covered by the available data falling in 131 lunar periods. The data showed a double peaked diurnal variation with maxima at 3 and 18 hr and minima at 9 and 21 hr with an amplitude of 6·1m V/km. J. M. HOUGH

550.371

6610. The electrical state of the earth's interior as inferred from variations in the earth's magnetic field. T. RIKITAKE. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 435–8 (1950).

An attempt is made to estimate the electrical conductivity σ of the earth at all depths from analysis of geomagnetic variations, using the theory and methods developed by Chapman and Price. Besides the *Sq*- and D_{st}-variations hitherto considered, S_D-variations, bays, crochets and SCs are discussed, and it is claimed that the results indicate that σ is about 10^{-15} e.m.u. for depths less than 400 km and about 10^{-12} e.m.u. for greater depths. A. T. PRICE

550.381

6611. An amplifier of the geomagnetic field for use with magnetron and magnetophone recorders. E. SELZER. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 408–410 (1950) *In French.*

A simple apparatus is described for amplifying the geomagnetic field, so that its rapid variations can be detected and recorded by means of Hull magnetrons or other detectors. It consists essentially of two large disks of soft iron joined by μ-metal to smaller disks between which the magnetron is placed. A magnification of about 30 is achieved, which makes it possible to use magnetrons with a potential difference greater than 100 V. A. T. PRICE

550.384

6612. Contribution to the study of geomagnetic effects of different manifestations of solar activity. A. ROMAÑÁ and J. M. PRINCEP. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 355–7 (1950) *In French.*

Crochets and bays in the magnetic records at Ebro during 1935–38, 1942–46 have been studied. Only 86 crochets were found, though 2 808 chromospheric eruptions are listed for these periods. Crochets are associated only with eruptions of character 3 and most frequently with those near the centre of the sun's disk. A daily variation of the frequency of occurrence is found. Bays have been classified according to their occurrence in H and/or D, and their sign. It is found that the type of bay depends on the time of day; this is discussed in terms of the ionospheric current systems which could account for these bays. A. T. PRICE

550.384

6613. Researches on the intensity of the geomagnetic field in the past. E. THELLIER AND O. THELLIER. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 422–5 (1950) *In French.*

These investigations are based on the assumption that the present magnetization of certain volcanic rocks, and of baked bricks, was produced at the time of their melting or baking, and that this magnetization has been retained almost unimpaired ever since. Tests for deciding if this latter condition is fulfilled are described; it is found to be only in a small percentage of cases. Examination of bricks from ancient buildings suggests that the intensity of the geomagnetic field has decreased during the last few centuries, but tests on metamorphic rocks from Puy-de-Dôme give no indication of a continued decrease during geologic time. A. T. PRICE

550.384.3

6614. On the secular variation of the geomagnetic field. M. A. DAUVILLIER. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 463–4 (1950) *In French.*

It is argued from thermal considerations that the sources of the geomagnetic field must lie within a depth of 20 km under the continents and 30 km under the oceans, and the secular variation is assumed to be produced by changes in the level of the isothermal surface corresponding to the Curie point of magnetite. It is suggested that there is a recognizable relation between the distribution of volcanoes and the observed secular variation field, and that this can be accounted for by the escape of part of the earth's radioactive heat through volcanic action. A new drift theory, in which a thin surface shell of the earth is assumed to slide over an inner core, is proposed to account for some anomalous features of the geomagnetic field. A. T. PRICE

550.384.4

6615. Longitudinal inequality of solar diurnal variation in geomagnetic field. T. NAGATA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 362–4 (1950).

The distribution of the *Sq*-field at various epochs G.M.T. is determined from Hasegawa's analysis of the data for 1932–33, and the corresponding changes throughout the Greenwich day of the position and intensity of the ionospheric current systems are inferred. The dynamo theory of the *Sq*-field is considered when account is taken of the non-coincidence of the geomagnetic and rotation axes. It is concluded that this non-coincidence is the cause of the changes in the *Sq*-field with universal time. A. T. PRICE

550.385

6616. Geomagnetic "sudden commencements" at Lerwick. D. H. MCINTOSH. *J. Atmos. Terr. Phys.*, **1** (*No.* 4) 223–32 (1951).

The occurrence of "sudden commencements" of geomagnetic storms at Lerwick is studied over a period of about 15 years, the movements being classified according to their form and also to the size of following disturbance. The forms taken by the "sudden commencement" movements are very variable but are found to be related to the hour of occurrence. No marked relationship is found between this systematic variation of form and normal diurnal movements on either geomagnetically quiet or disturbed days. The average effect of all Lerwick sudden commencements is shown to be opposed to the main disturbance field. A.

550.835 : 539.16

6617. Logging of drill holes by the neutron, gamma method, and gamma ray scattering. H. FAUL AND C. W. TITTLE. *Geophysics*, **16**, 260–76 (*April*, 1951).

The intensity distribution of secondary gamma radiation resulting from neutron capture has been

measured in simulated drill holes, of various types such as cased and uncased, empty and water-filled. The intensity of neutron-capture gamma rays depends on the hydrogen content of the rock. The slope of logarithmic gamma ray intensity *v.* distance remains virtually constant. It changes with the hydrogen content of the formation and offers a means of quantitatively estimating porosity behind casing despite extraneous absorption. The slope can be measured automatically in the well by two gamma detectors placed in a probe at fixed distances from a neutron source. A.

550.838

6618. Techniques and results of aeromagnetic surveying. J. R. BALSLEY. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 413–18 (1950).

The usefulness, applicability and economy of airborne magnetometers for geophysical prospecting are evaluated in the light of experience gained in 300 000 miles of aeromagnetic surveys in U.S.A. Different factors influence the reliability of the results of aerial and ground surveys. Aerial surveys have the advantage that a continuous magnetic profile is obtained between two points in a very short time, so that inaccuracies due to instrument drift and geomagnetic time-variations are greatly reduced. On the other hand, errors of order 50–200 ft may occur in determining position. For large areas the airborne magnetometer can provide at low cost a reasonably accurate magnetic map, which will indicate those localities suitable for more detailed and expensive ground work, both geological and geophysical.

A. T. PRICE

550.93 : 539.16.08

6619. Dating late-pleistocene events by means of radiocarbon. R. F. FLINT. *Nature, Lond.*, **167,** 833–6 (*May* 26, 1951).

A summary of the progress so far made in the dating of dead organic matter by measuring the proportion of radiocarbon in the carbon content. The experimental technique is outlined and the theoretical assumptions discussed with especial reference to the accuracy of the dates obtained. The main conclusions are: (*a*) most of the radiocarbon dates support the relative stratigraphical positions of the specimens; (*b*) the dates of events in the Fourth Glacial age are much less than previously estimated; (*c*) climatic changes in northern and western Europe seem to have approximately coincided with those in North America. A number of particular cases are discussed and the dates are usually given with an uncertainty of about 5%. J. M. HOUGH

ATMOSPHERE . METEOROLOGY 551.5

551.51 : 551.52

6620. The formation of radiation clouds. A. G. AMELIN. *Dokl. Akad. Nauk, SSSR,* 77 (*No.* 2) 249–52 (1951) *In Russian.*

Theoretical. In order to forecast the possibility of formation of a radiation cloud and the time of its formation it is necessary to solve the equation $S_{(x,\tau)} = p_{(x,\tau)}/e^{C-E/T(x,\tau)}$ where S is the supersaturation; p the vapour pressure in the air; τ the time; x the distance from the ground; T the absolute temp. and C and E coeffs. If turbulent diffusion is neglected then the process of the transfer of the mass of air (vapour condensation) and the heat transfer near the ground can be expressed by $\partial p/\partial\tau = D\partial^2 p/\partial x^2$ and $\partial T/\partial\tau = a\partial^2 T/\partial x^2$ respectively, where D is the diffusion coeff. and a the coeff. of temp. conductivity of the air. A solution of these equations in the form

$$T_{(x,\tau)} = T_0 - k\tau\left\{\left(1+\frac{z^2}{2}\right)\left[1+\phi\left(\frac{z}{2}\right)\right] - \frac{z}{\sqrt{\pi}}e^{-\frac{z^2}{4}}\right\}$$

is obtained where ϕz is a transcendental Kramp function $z = x/\sqrt{a\tau}$. The divergence between practical results and those calc. from this equation is probably due to neglect of factors such as the presence of condensation nuclei in the air and turbulent diffusion.

W. HUGHES

551.510.4

6621. Recent work on the measurement of atmospheric ozone and its vertical distribution in India. K. R. RAMANATHAN AND R. W. KARANDIKAR. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 492–4 (1950).

Measurements of mean monthly values of O_3 at Delhi over 17 months show a main maximum April–June, a mean minimum November and a secondary minimum in August. A high O_3 content is shown with N'ly winds but no connection with fronts is established. Measurements of zenith scattered light are used to establish the height distribution of O_3 and its change with latitude. R. S. READ

551.510.41

6622. The evolution of the earth's atmosphere. J. H. J. POOLE. *Sci. Proc. Roy. Dublin Soc.*, **25,** 201–24 (*May*, 1951).

The composition of the earth's atmosphere before the formation of the ocean is discussed and recent theories on its origin confirm that it contained no free O_2. From considerations of the mechanisms suggested to explain the subsequent production of free O_2 it is concluded that although free O_2 has been mainly produced from CO_2 by photosynthesis, some non-biological process of O_2 production is necessary to enable the former process to start. Tammann's thermal dissociation theory and the author's and Harteck and Jensen's photo-dissociation theory are discussed. It is shown that although the period between the solidification of the crust and the formation of the ocean must have been short this is not a fundamental objection to Tammann's theory if an isothermal atmosphere is assumed. If, however, Milankovitch's views on the temperature gradient in the atmosphere during this period are correct, Tammann's theory must be invalid. It is concluded that while in a qualitative sense the photo-dissociation theory is probably sound, quantitative results are not yet possible. Harteck and Jensen's estimate of the rate of production of O_2 by this process is considered excessive on geochemical grounds and as recent experimental measurements show that the air near

the tropopause is surprisingly dry. Finally, geological evidence of the absence of free O_2 from the atmosphere during a considerable part of the earth's lifetime is given. R. S. READ

551.510.41 : 539.163.2

6623. Origin of atmospheric argon and the radioactive decay constants of potassium-40. J. H. J. POOLE AND C. F. G. DELANEY. Letter in *Nature, Lond.*, **167**, 680–1 (*April* 28, 1951).

The most recent determinations of the decay constants lead to the conclusion that atmospheric A cannot be due to K^{40} decay unless it has diffused from a considerable depth in the earth.

551.510.5

6624. The use of rockets in upper atmospheric research. J. A. VAN ALLEN. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 531–6 (1950).

Using German V–2 rockets in New Mexico ascents were made up to 184 km. Results were obtained either by radio signals from a transmitter or on physical recovery of records relating to primary cosmic rays, pressure and temperature to 120 km, distribution of O_3, extension of the solar spectrum to 2 300 Å refraction of radio waves in the *E*-layer, sky brightness and composition of air samples. A new rocket (Aerobee) has been used to 115 km to obtain cosmic ray and the earth's magnetic field data. An extension is required to other areas and seasons, different meteorological conditions and during solar, ionospheric and magnetic disturbances. R. S. READ

551.510.5 : 523.51

6625. Exploration of the upper atmosphere by meteors. F. LINK. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 496–9 (1950) *In French.*

Numerical values are obtained of the gradient of air density from considerations of amount of heat produced in the air as the meteor traverses it and the transformation of kinetic energy of the meteor into visible radiation. An upper limit of the density gradient between 80 and 110 km, where most meteors are observed, is $0{\cdot}72\times10^{-6}\,\mathrm{cm}^{-1}$. This agrees well with values obtained by other means. R. S. READ

551.510.535

6626. On the variations of electron and ion densities in the F2-layer at the time of the solar eclipse on February 5, 1943. T. YONEZAWA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 358–60 (1950).

Negative ion and electron densities are computed. The latter agree approximately with observed values. Temperature expansion and corona radiation effects are neglected. W. C. A. HUTCHINSON

551.510.535

6627. Continuous recording of dominant ionospheric characteristics. L. V. BERKNER. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 371–2 (1950).

Note on the principles underlying an ionospheric recorder which will provide a continuous ink record of critical frequency, equivalent height or ionospheric absorption. W. J. G. BEYNON

551.510.535

6628. Characteristics of sporadic *E*. H. W. WELLS. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 372–3 (1950).

Short discussion of some aspects of variations in the occurrence of sporadic *E* ionization. The topics mentioned include the diurnal, seasonal, sunspot-cycle and latitude variations. W. J. G. BEYNON

551.510.535

6629. Characteristics of *E*-region sporadic ionization in Canada. J. H. MEEK. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 373–5 (1950).

Studies of ionospheric records from Canadian stations show many distinct types of sporadic *E* traces. Details are given of the 6 classes into which sporadic *E* traces have been divided for analysis purposes. W. J. G. BEYNON

551.510.535

6630. Worldwide distribution of the ordinary component critical frequencies of *F*2-layer. H. UYEDA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 385–9 (1950).

The critical frequency, its minimum value extrapolated to S (relative sunspot No.) = 0, and its daily variation of amplitude (and possibly its rate of change with S for various latitudes) show a symmetrical distribution when plotted against geomagnetic latitude. W. C. A. HUTCHINSON

551.510.535

6631. Electron annihilation in the *F*2-layer. O. BURKARD. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 381–5 (1950).

If the influence of variable activity of the sun is eliminated from the nightly diminution of the *F*2-ionization, there results a linear law in the form of $dn/dt = \beta n$. The value of β is found to be about $1\cdot10^{-4}\,\mathrm{sec}^{-1}$. The seasonal variation of β is investigated for the stations Huancayo, Kochel (near Munich), and Watheroo. If this variation is due to a temperature-effect, the summer temperature must be about three times larger than the winter temperature at middle latitudes. A.

551.510.535

6632. Ionospheric bays accompanying geomagnetic bays. T. NAGATA AND N. FUKUSHIMA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 390–3 (1950).

By comparing geomagnetic and ionospheric data, which were obtained at Kakioka (36·2° N, 140·2° E) and at Kokubunji (35·7° N, 139·5° E) respectively, it was found that a geomagnetic bay is accompanied by a variation in the critical frequency of F_2 layer, which is also of a bay-type. This particular variation in ionosphere is named "ionospheric bay." A.

550.510.535

6633. The gyro-frequency in the Arctic *E*-layer. J. C. W. SCOTT. *J. Geophys. Res.*, **56**, 1–16 (*March*, 1951).

Calculation of the gyro-frequency in the *E*-layer at arctic stations from measurements of critical radio-frequency differences gives a lower magnetic field than that obtained by extrapolation of the terrestrial field measured at ground-level, and, at one station, a large semi-diurnal variation. Ray-path deflections which can explain similar effects previously reported for the *F*-layer cannot be responsible in the *E*-layer because of the opposite sense of this deviation and because of the small layer-thickness. Moreover, no semi-diurnal variation was found in the *F*-layer. It

is shown that these new *E*-layer phenomena may be due to a variable concentration of heavy ions rising to over 4 000 times the density of free electrons. A.

550.510.535

6634. Fine structure of the lower ionosphere. R. A. HELLIWELL, A. J. MALLINCKRODT AND F. W. KRUSE, JR. *J. Geophys. Res.*, **56**, 53–62 (*March*, 1951).

Pulse soundings of the ionosphere at vertical incidence taken at 100 and 325 kc/s show pronounced splitting of the echoes received at night. The ranges of most of the echo components are found to lie between about 90 and 130 km. Four possible explanations of splitting are suggested, as follows: (1) off-vertical reflections, (2) magneto-ionic splitting, (3) partial reflection in a layer of monotonically increasing ionization-density, and (4) division of the region into a series of partially-reflecting partially-transmitting strata. Experimental data are not consistent with the first 3. The 4th is consistent with all available data. It is concluded that the lower ionosphere contains at night a system of reflecting strata at discrete heights, capable of both reflecting and transmitting incident electromagnetic energy. A.

550.510.535

6635. Fine structure of the ionospheric region *E*. H. A. WHALE. *J. Atmos. Terr. Phys.*, **1** (*No.* 4) 233–43 (1951).

Complications in the structure of Region *E* of the ionosphere are discussed in the light of experimental (h', f) curves. The experimental curves are compared with theoretical curves calculated for various model ionospheres. While some of the observed complications appear to be due to subsidiary regions of various kinds occurring together with the simple Region *E*, others appear to be due to irregularities or "ledges" in the normal Region *E*. Examples of stationary and moving ledges are given. Some of the consequences of the presence of scattering centres are discussed and a typical experimental record shown. A.

550.510.535

6636. Determination of electron densities in the ionosphere from experimental (h', f) curves. H. A. WHALE. *J. Atmos. Terr. Phys.*, **1** (*No.* 4) 244–53 (1951).

It is shown how a differential analyser can be used to facilitate the calculation of ionospheric distributions of electron density directly from observed (h, f) curves by previously known methods. It is pointed out that the simple method, in which the earth's magnetic field is neglected, leads to inacceptable results. A modified method by which the effect of the earth's field can be approximately allowed for is described and it is shown that, when this method is employed, feasible results are obtained. A.

551.513

6637. Lateral turbulence in the atmosphere. J. VAN MIEGHEM. *Meded. K. Vlaamse Acad. Wetensch. Belg.*, **12** (*No.* 14) 16 *pp.* (1950) *In Dutch.*

The components of the Reynolds tensor are calculated for the isentropic case, and the rate of production of kinetic energy and the criterion for turbulence are established. The transversal mixing increases or decreases as the absolute value of the transverse isentropic gradient is greater than or less than the parameter of Coriolis. J. M. HOUGH

551.513

6638. Winds and turbulence in the upper atmosphere. *Nature, Lond.*, **167**, 626–8 (*April* 21, 1951).

Radio methods were used by Lovell and Ryle, Munro, Beynon, Bramley, Phillips and Manning, and the results indicated that the atmosphere is turbulent, and drift velocity occurs at heights varying from 90 to $>$ 300 km. Diurnal and seasonal changes and reversals of velocity were indicated. The results were summarized and tabulated by Ratcliffe. Numerical values of temperature difference required to produce these movements were quoted by Sheppard. The necessity for accurate measurements of height and the fact that horizontal movements of irregularities of electron density do not necessarily imply bodily movements of air were stressed. R. S. READ

551.513 : 551.465

6639. On the vertical and horizontal concentration of momentum in air and ocean currents. I. Introductory comments and basic principles, with particular reference to the vertical concentration of momentum in ocean currents. C.-G. ROSSBY. *Tellus*, **3**, 15–27 (*Feb.*, 1951).

An investigation into the factors which are responsible for the characteristic "streakiness" of certain atmospheric and oceanic current systems. A search is made for those which might give rise to the striking vertical concentration of momentum observed in many well-defined atmospheric and oceanic jet streams. A straight, parallel, heterogeneous and incompressible current with a free surface, hydrostatic pressure distribution and a continuous density field is analysed theoretically to determine the particular distribution of velocity with depth which, for a prescribed volume transport within each isopycnic layer, leads to a minimum value for the transfer of momentum. This requirement leads to a certain "critical" relationship between the velocity and density distribution which in the case of a two-layer system reduces to the well-known critical relative speed at an internal fluid boundary. In the general case it is found that currents which are subjected to momentum losses must shrink vertically and develop a sharp velocity maximum at or below the free surface. A.

551.521.1

6640. Solar radiation at Kew Observatory. J. M. STAGG. *Geophys. Mem. Met. Off.*, *No.* 86, 37 *pp.* (1950).

Pt I deals with direct solar radiation at normal incidence, measured by a Gorczynski pyrheliograph. Monthly totals are given for 1933–46, totals for various categories of days, frequency distributions and tables of hourly values; the latter are related to sun's altitude and air mass. They are analysed into south, west and vertical components for information of architects. Reduction of direct radiation by scattering, absorption and reflection is analysed and various measures of atmospheric transmission discussed. Pt II deals with direct and diffuse short wave

radiation from sun and sky on a horizontal surface; monthly, hourly and extreme values are given and related to sun's elevation and cloud type.

METEOROLOGICAL ABSTRACTS

551.578.1

6641. 1948–1949 trials of the Schaefer-Langmuir cloud-seeding technique in Hawaii. L. B. LEOPOLD AND W. A. MORDY. *Tellus*, **3**, 44–52 (*Feb.*, 1951).

Fifteen tests during 1948–49 involving 37 individual cloud inoculations over the islands of Lanai and Molokai are described. With regard to the role of the dry ice in causing the observed rainfall, the tests are too few in number to be considered conclusive, but the large rainfall values associated with seeded clouds are of particular interest. The largest rains seem to be associated with clouds where cloud top temperatures are slightly colder than 0°C and such clouds are also relatively thick. The relative importance of cloud thickness and temperature cannot be determined from the available data. A.

551.583.13

6642. On the periodicity of the recent changes in our climate. I. HELA. *Ann. Acad. Sci. Fennicae, Ser. A I, No.* 84, 9 *pp.* (1950).

An extension of Alt's examination of the regional distribution of the degree of continentality and maritimity over Europe and the North Atlantic is applied to the secular fluctuations of air pressure at Helsinki, Stockholm and Oulu. Maximum amplitudes are indicated at 11, 13, 21 and 44 years. Periods near to 44 years are indicated for hard winters in Germany, Stockholm summer temperatures, Dutch mean temperatures, currents in the North Sea, herring yields in the North Sea and cod fishery in the Lofotens. No explanation is obtained of the continued increase in air temperature in recent years.

R. S. READ

551.593.53/.7

6643. Colour and brightness of the sky. H. G. W. HARDING AND G. E. V. LAMBERT. Letter in *Nature, Lond.*, **167**, 436–7 (*March* 17, 1951).

Results obtained from aircraft at 20 000 ft and 40 000 ft. A perfect match with the colour of the sky could not be obtained. The polarization factor varied with direction between 0·28 and 0·50 at 20 000 ft, and between 0·42 and 0·66 at 40 000 ft.

N. CORCORAN

551.593.9

6644. On the mechanism of the illumination of the night sky. V. I. KRASOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 3) 395–8 (1951) *In Russian.*

Theoretical. The intensities of the OH lines given by Meinel [Abstr. 7121 (1950)] are tabulated and critically discussed. The ozone-hydrogen mechanism for excitation of OH [Bates and Nicolet, Abstr. 7649 (1950)] is at variance with the results of Rodionov [Abstr. 3991 (1951)] and another mechanism is proposed by the present author. It is postulated that N_2O is formed in large amounts as a result of ternary collisions in the zone where dissociated O_2 exists, but as a result of diffusion the N_2O is vertically displaced to higher levels. The N_2O then reacts according to a bimolecular reaction with atomic oxygen, forming nitrogen and excited O_2 molecules which on further collisions with hydrogen atoms yield excited OH. (1) $N_2 + O \rightarrow N_2O$; (2) $N_2O + O \rightarrow N_2 + O_2^*$; (3) $O_2^* + H \rightarrow OH^* + O$. There are no grounds for rejecting the generally accepted mechanism for the excitation of molecular and atomic oxygen by ternary collisions. W. HUGHES

551.593.9 : 551.510.5

6645. Remarks on the excitation of hydrogen and helium in the upper atmosphere. W. PETRIE. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 466–70 (1950).

Lines of H and He have been observed occasionally in the auroral spectrum, and their intensities estimated. The observed H-line intensities are incompatible with a suggested proton-electron recombination, nor can solar u.v. radiation excite to the required degree the first 3 Balmer lines. Experimental evidence indicates collisional excitation as source of the observed auroral lines. For both H and He atoms excited by electron impact, computed relative intensities agree closely with those observed in the auroral spectrum. For H, electron velocities corresponding to $T \simeq 7\,600°K$ are found, a value very different from that found by Vegard for N_2, viz. $T = 300°K$.

D. R. BARBER

551.593.9 : 551.510.5

6646. Laboratory studies related to the physics of the upper atmosphere. J. KAPLAN. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 474–9 (1950).

A review of the author's work on afterglow-spectra of N and O. The strong auroral (N) afterglow exhibits a marked time-variation, starting with a simulation of the polar auroral spectrum, and later resembling that of the night-sky. The weak (N) afterglow characterizes the n.s. spectrum throughout its entire duration, *c.* 10 sec. The spectrum of the newly-discovered O afterglow is predominantly that of atomic O in the normal (^3P) level. It is suggested that dissociative recombinations, and collisions of the 2nd kind between slow electrons, and metastable atoms and molecules play significant roles in the production of upper-air spectra. D. R. BARBER

551.593.9 : 551.510.5

6647. Properties of the upper atmosphere revealed through spectral analyses of aurorae and twilight. L. VEGARD. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 479–90 (1950).

A review, with critical commentary by H. Alfvén, of luminescent and ionospheric phenomena of the upper air, based on the author's well-known particle-emission theory of the solar, and terrestrial coronas.

D. R. BARBER

551.593.9 : 551.510.5

6648. Optical soundings of the upper atmosphere with the help of lunar eclipses. F. LINK. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 502–3 (1950) *In French.*

Observations of the optical density of the earth's shadow show it to be a function of distance from the centre, and from photometric theory the density of the shadow can be calculated. Differences between calculated and observed values are due to unknown properties of the atmosphere. The optical density is

due to (*a*) strongly selective molecular diffusion and (*b*) refraction, the former being more important at the centre and the latter at the edges. The differences between observed and calculated values are plotted as a function of the mean mass of air passed through. The difference increases rapidly from 24 km to the top of the O_3 layer. A further layer is indicated at 100 km which may be meteoric dust. R. S. READ

551.593.9 : 551.510.5

6649. The possibility of optical sounding of the high atmosphere using twilight phenomena. F. LINK. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 504–6 (1950) *In French.*

Hulbert's criticism of the author's method for determining the change of atmospheric density with altitude, from measures of zenith sky-brightness at twilight, is refuted. It is shown that if observations are made in the near infrared (*c.* 8 000 Å) the influence of secondary light-scatter becomes negligible. D. R. BARBER

551.594.11.08

6650. The recording of field strengths of atmospheric electricity. E. VON KILINSKI. *Z. Met.*, **4**, 77–81 (*March*, 1950).

Recording of field strength with thorium, collector and electrometer tube and with a new field recorder is summarized; the construction of the latter is described. The V-shaped standard curves which it gives are somewhat ambiguous; possible improvements are discussed and illustrated, including a commutator and auxiliary generator.

METEOROLOGICAL ABSTRACTS

551.594.13 : 550.38

6651. A suggestion for the electric conductivity of the upper atmosphere from an analysis of the diurnal variations of terrestrial magnetism. M. HASEGAWA. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 507–9 (1950).

From the results of 19 observatories in the north polar region for the magnetic *S* field the author concludes that (1) the ring electric current band near the maximum aurora zone has a considerable breadth, its outside boundary being distinct; (2) the dimension of the ring varies with the season of the year and the magnetic activity of the day. J. M. HOUGH

551.594.13.08

6652. Registering apparatus for the measurement of high and variable resistance: application to the measurement of electric conductivity of the air. A. GODEFROY. *Ann. Géophys.*, **5**, 164–6 (*Feb.*, 1949) *In French.*

This is a description of an apparatus for measuring high and variable resistances. It can eliminate errors due to variations in the characteristics of the amplifiers needed for recording and it can measure resistances of 10^{14} ohms with a precision of 1%. A circuit diagram is given and the theory underlying the apparatus is presented. METEOROLOGICAL ABSTRACTS

551.594.221

6653. Upward lightning discharges from thunderclouds. R. MÜHLEISEN. Letter in *Naturwissenschaften*, **38** (*No.* 6) 140 (1951) *In German.*

Following a period of lightning discharges to earth, a sequence of more than 10 discharges was observed which started from the top of a thundercloud at a height of ~ 3 miles and branched upwards towards the upper atmosphere. R. H. GOLDE

551.594.51

6654. Auroral spectra showing broad hydrogen lines. C. W. GARTLEIN. *Int. Ass. Terr. Magn. Elect. Bull., No.* 13, 491 (1950).

The appearance of broadened lines of Hβ and Hγ (line-width at least 5 Å > that of 5 003 Å) has been confirmed on 44 occasions since 1943. On 14 nights, the H lines appeared before, and during sudden enhancement of the auroral radiations. This suggests proton streams entering the atmosphere, and possibly "triggering" the auroral outburst. Spectrograms of quiescent auroras do not reveal H lines. Frequently the auroral outbursts are concurrent with sudden changes in terrestrial magnetism. D. R. BARBER

BIOLOGY 57/59

577

6655. Progress in biophysics and biophysical chemistry. I. J. A. V. BUTLER AND J. T. RANDALL (ED.) *London, Butterworth-Springer* (1950) 279 *pp.*

A collection of 9 separate papers, covering different aspects of the application of physical methods to the study of living structures and the characteristic molecules of which they are composed. The subject of radioactive tracers in biology has been deliberately omitted, in view of other publications. The contents are as follows: (1) *Properties of solutions of large molecules* (H. Gutfreund), including details of methods and a discussion of the molecular constants of some proteins; there is a section on the osmotic pressure of real solutions; (2) *Fundamental structures in biological systems* (K. M. Rudall), covering polypeptides, proteins, polysaccharides and polynucleotides; (3) *Scattering of visible light and X-rays by solutions of proteins* (G. Oster); (4) *Bioelectric potentials, their maintenance and function* (E. E. Crane), including discussions of the occurrence and the causes of biological potential differences, specific electric organs, the relation of bioelectric potentials to secretory function, and bioelectric potentials as a source of energy; (5) *Phase-contrast microscopy in biological research* (A. F. W. Hughes); (6) *Local refractometry: the observation of transparent inhomogeneous matter* (J. St. L. Philpot), dealt with theoretically; (7) *Use of soft X-rays in the assay of biological materials* (A. Engström), containing both theoretical and practical treatment; (8) *The tolerance of man for radioactive isotopes* (J. F. Loutit), including sections on the metabolism, elimination, and effect of retention, of radium; (9) *Mechanical properties of fibres and muscles* (M. G. M. Pryor), including the thermodynamics of elastic strains, elastic power cycles, description of a model of a chemical engine, and discussion of application to muscle. Each paper carries an extensive bibliography, and there are Author and Subject Indexes. E. E. CRANE

591.185.63 : 525.37 : 531.114

6656. A preliminary study of a physical basis of bird navigation. II. H. L. YEAGLEY. *J. Appl. Phys.*, **22**, 746–60 (*June*, 1951).

See Abstr. 1132 (1948). The present report presents the results obtained since July, 1945, and up to the summer of 1949. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.813 : 541.133

6657. Application of quantum statistics to ionic currents. A. GOUDOT. *C.R. Acad. Sci., Paris*, **232**, 1741–3 (*May* 7, 1951) *In French.*

Upon nerve stimulation with a moving negative electrode the ionic layer (cloud) K^+ will move with a given velocity which is $\propto$ to the density and the surface of the ion cloud. Each ion K^+ can be attached to a resonator of mass m and charge e. If a sinusoidal current acts on the nerve the ions will produce forced oscillations. At the point where the resonators are in resonance with the current the velocity of the energy transport is a max. Calculations and graphic representation show an absorption band to exist which is similar to Brillouin's absorption and seems to represent the pseudo-capacity on the ionic scale, a fact that was inexplicable on the macroscopic scale. W. SUMMER

612.843.31

6658. Retinal colour responses to micro-stimulation. K. MOTOKAWA, M. EBE, Y. ARAKAWA AND T. OIKAWA. Letter in *Nature, Lond.*, **167**, 729–80 (*May* 5, 1951).

Using a test-field of 2 min and an electric phosphene as an indicator, the authors determined curves for "colour-mechanisms" 30 min and 20° from the human foveal centre. In addition to the red, green and blue mechanisms, previously reported, they now claim the discovery of a yellow one in the fovea. R. A. WEALE

612.843.611

6659. Dark adaptation. A. ROSE. Letter in *J. Opt. Soc. Amer.*, **41**, 210 (*March*, 1951).

It is suggested that the nervous component of dark adaptation predominates over the photochemical. R. A. WEALE

612.843.611

6660. Time of dark adaptation after stimulation by various brightnesses and colors. E. O. HULBURT. *J. Opt. Soc. Amer.*, **41**, 402–4 (*June*, 1951).

Experiments were carried out in which an observer, previously dark adapted, was stimulated for 3 minutes by fields of various brightnesses and colours and the time required for him to become dark adapted again was measured. It was found (1) that for stimulation at 6 foot-candles by equally bright fields of various colours the times to become dark adapted were about 4, 5, 7, 11 and 13 minutes for wavelengths 650, 600, 550, 500 and 450 mμ, respectively; stimulation by the ultraviolet 366 mμ line caused little disturbance to dark adaptation at the intensity used; (2) that for equally bright white and red 650-mμ stimulations at 0·1, 1, 10 and 100 foot-candles, the times to become dark adapted were about 4, 5, 10 and 21 minutes for white and 3, 4, 5 and 7 minutes for red, respectively. A.

612.85

6661. Upper limit of frequency for human hearing. J. H. COMBRIDGE AND J. O. ACKROYD; R. J. PUMPHREY, Letters in *Nature, Lond.*, **167**, 438–9 (*March* 17, 1951).

Combridge and Ackroyd draw attention to a demonstration by Maass (Bremen) claiming that bone-conducted vibrations can be heard, with pitch discrimination, up to 50 kc/sec by persons totally deaf at ordinary frequencies, both to airborne and bone-conducted sound. Pumphrey, in his reply, is sceptical: (*a*) he is dubious about assessment of total deafness; and (*b*) he considers that frequency-discrimination is not possible above 16 kc/sec.

A. B. WOOD

612.85

6662. A duplex theory of pitch perception. J. C. R. LICKLIDER. *Experientia*, 7 (*No.* 4) 128–34 (1951).

The essence of this theory is that the auditory system employs both frequency analysis (by the cochlea) and autocorrelational analysis (by the neural part of the system). The mechanism is considered in detail and the results applied to account for observations which cannot be explained by simple frequency analysis theories. Brief reference is made to neurological evidence in support of the mechanism proposed. G. F. HODSMAN

612.85 : 534.321.5

6663. Physiological origin of the sensation of dissonance, and the reduction of musical aesthetics to the psycho-physiology of the auditory nerve and its relays. R. HUSSON. *C.R. Acad. Sci., Paris*, **232**, 1589–91 (*April* 23, 1951) *In French.*

Observations indicate:—(1) When two sounds arrive separately, the first in one ear, the second in the other ear, there is never dissonance whatever their interval; (2) when the two sounds reach the same ear simultaneously the dissonance appears near the interval 1·05 and disappears near the interval 1·16 (below the minor third). Above the interval 1·16 there is never dissonance; (3) between the intervals 1·05 and 1·16 the ear perceives a modulation of intensity, first slow then more and more rapid. This alternating rapid change of intensity in the ear of the two sounds is the cause of dissonance. The physiological implications of these observations are discussed. A. B. WOOD

614.8

6664. Drugs for protection against atomic radiation. J. F. LOUTIT. *Atomics, Lond.*, **2**, 143–6 (*May*, 1951).

The effects of radiations are briefly discussed under the heads of physical, chemical and biological action. Each of these suggests a different approach towards prophylactic agents. Thus, by administering a reducing agent, e.g. cysteine, chemical effects due to radiations can be lessened. Biological effects include (i) haemorrhage (where treatment with a coagulant such as protamine sulphate and with "vitamin P" substances, have had effect); and (ii) infection. Here penicillin and aureomycin have some success. It is considered that most observed protective effects are due to direct or indirect protection of the haemopoietic tissues. There is little hope at present that these results do more than indicate the trend of research.

D. V. MABBS

614.8 : 539.16.08

6665. Measurement of radioactivity in human breath. A. H. WARD AND P. G. JENSEN. Letter in *Nature, Lond.*, **167**, 600 (*April* 14, 1951).

Measurements of the α-ray activity of breath are a useful indication of the type and amount of internal radioactive contamination. The first method uses a 4-litre ionization chamber in which the exhaled breath is collected and the second method uses a continuous flow counter which is more suitable for thoron measurements. Results on 16 patients indicate these have concentrations in breath of ~ 100–300 $\mu\mu$C/litre, the corresponding Th burden is 2–10 g, initially equivalent to 0·2–1·0 μC. Details of the continuous flow counter are given.

T. A. CHALMERS

615.849

6666. Considerations in the use of a 23-MeV medical betatron. J. S. LAUGHLIN. *Nucleonics*, **8**, 5–16 (*April*, 1951).

The therapeutic advantages of the 23 MeV betatron X-rays over, say, 200 keV X-rays are outlined. Most important are the more uniform depth dose distribution and nearly equal mass absorption coefficients of the former radiation in bone, muscle and tissue and fat. Measurement of intensities and energies of stray X-rays and photo-neutrons in the vicinity of the betatron are described. It is shown that these do not constitute a serious health hazard to the patient.

L. R. SHEPHERD

615.849 : 537.531

X-ray dosage. *See Abstr.* 6253

PHOTOGRAPHY 77

771.35

6667. A new form of *f*/0·71 lens for 35 mm cine-radiography. C. G. WYNNE. *J. Sci. Instrum.*, **28**, 172–3 (*June*, 1951).

The causes are discussed of the relatively poor performance of earlier very wide aperture lenses designed to cover a flat field. A new approach to the problem is described, and details given of the performance of an *f*/0·71 lens for 35 mm cine-radiography designed on this principle.

A.

771.53 : 548.7

6668. The nature of photosensitivity of photographic emulsions. P. V. MEĬKLYAR. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 3) 391–4 (1951) *In Russian.*

A survey of recent work, mainly by Soviet investigators, confirming the theory advanced by the author and Putseiko [Abstr. 8622 (1950)] explaining the role of *F*-centres formed in the crystals of Ag halides.

F. LACHMAN

771.534.5 : 537.531

6669. Characteristics of some films for 20 million volt X-rays. G. D. ADAMS. *Non-Destr. Test.*, **9** (*No.* 3) 6–9 (1950–51).

20 MeV X-rays are used industrially mainly for the radiography of steel. Characteristic curves for several types of American X-ray film are given, the betratron beam having 2 in of steel interposed between target and film. A set of curves shows the incident dose necessary to produce density = 2 (under standard development conditions) through thicknesses of steel up to 16 in, and for film-target distances of 3–18 ft. These are curves for a particular emulsion, but they can be used for others, by altering the indicated exposure times in the ratio of the speeds.

D. V. MABBS

771.534.554

6670. The measurement of the granularity of photographic images. R. DEBOT. *Mem. Soc. Roy. Liège*, **10** (*No.* 4) 1–258 (1950) *In French.*

The granularity of negative materials has been defined in terms of the standard deviation of the transparency σ_T and the area of the scanning spot a. This definition assumes a Gaussian distribution of the transparency and that the transparencies of different areas of the plate are independent. These assumptions have been verified approximately except for neighbouring areas. An electronic granularity machine is described which facilitates accurate measurement of σ_T by taking averages over a large number of individual measurements. The theoretical relationship $\overline{\text{Log}\,\sigma_T\sqrt{(a)}}$ = constant has been found to hold for negative materials, but for enlargements $\log\sigma_T\sqrt{(a)}$ increases rapidly as the scanning area increases. There is an approximate correlation between the granularity of a negative and its enlargement provided the scanning areas in both cases are large enough. A review of the literature published since 1920 is given.

A. C. COATES

778.3

6671. Use of liquid nuclear research emulsion in track autoradiography. M. BLUNDELL AND J. ROTBLAT. Letter in *Nature, Lond.*, **167**, 645–6 (*April* 21, 1951).

The intimate contact between the specimen and the emulsion obtained with liquid emulsion techniques, produces undesirable effects which can be eliminated by having a thin protective layer between the specimen and the emulsion. A method is described for obtaining such a layer using a 1% solution of "Perspex" in chloroform.

A. C. COATES

778.3 : 537.534.75

Range-energy relations in photographic emulsions. *See Abstr.* 6269–71

778.33 : 537.531.8

6672. Comment on nomenclature in "Electron microradiography of electrodeposited metals." G. M. CORNEY. Letter in *J. Appl. Phys.*, **22**, 682–3 (*May*, 1951). See Abstr. 777 (1951).